

Immunology

The following items have been identified generally as appropriate for both entry level medical laboratory scientists and medical laboratory technicians. Items that are appropriate for medical laboratory scientists **only** are marked with an "MLS ONLY."

229 Questions

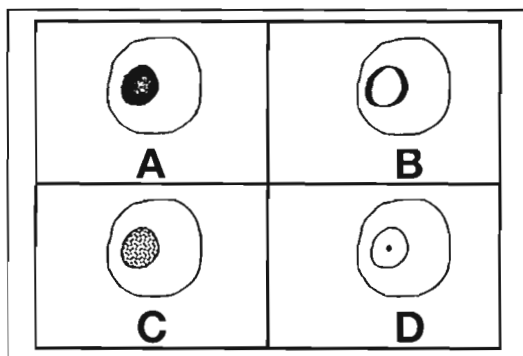
- 229 Autoantibody Evaluation
- 240 Infectious Disease Serology
- 248 Protein Analysis
- 258 Cellular Immunity and Histocompatibility Techniques

264 Answers and Explanations

- 265 Autoantibody Evaluation
- 268 Infectious Disease Serology
- 271 Protein Analysis
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Autoantibody Evaluation

- 1 Antinuclear antibody tests are performed to help diagnose:
 - a acute leukemia
 - b lupus erythematosus
 - c hemolytic anemia
 - d Crohn disease
- 2 MLS ONLY In the anti-double-stranded DNA procedure, the antigen **most** commonly utilized is:
 - a rat stomach tissue
 - b mouse kidney tissue
 - c *Crithidia luciliae*
 - d *Toxoplasma gondii*
- 3 Refer to the following illustration:



Which of the ANA patterns shown above would be associated with high titers of antibodies to the Sm antigen?

- a diagram A
- b diagram B
- c diagram C
- d diagram D

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- 4 Sera to be tested for IFA-ANA 6 days after drawing is best stored at:
- a room temperature
 - b $5^{\circ}\text{C} \pm 2^{\circ}\text{C}$
 - c -70°C in a constant temperature freezer
 - d -20°C in a frost-free self-defrosting freezer
- 5 Antibodies directed at native DNA are **most** frequently associated with which pattern of fluorescence in the IFA-ANA test?
- a rim
 - b diffuse
 - c speckled
 - d centromere
- 6 The technologist observes apparent homogenous staining of the nucleus of interphase cells while performing an IFA-ANA, as well as staining of the chromosomes in mitotic cells. This result is:
- a indicative of 2 antibodies, which should be separately reported after titration
 - b expected for anti-DNA antibodies
 - c inconsistent; the test should be reported with new reagent
 - d expected for anti-centromere antibodies
- 7 The result of an anti-nuclear antibody test was a titer of 1:320 with a peripheral pattern. Which of the following sets of results best correlate with these results?
- a anti-dsDNA titer 1:80, and a high titer of antibodies to Sm
 - b antimitochondrial antibody titer 1:160, and antibodies to RNP
 - c anti-Scl-70, and antibodies to single-stranded DNA
 - d high titers of anti-SS-A and anti-SS-B
- 8 Systemic lupus erythematosus patients often have which of the following test results?
- a high titers of DNA antibody
 - b decreased serum immunoglobulin levels
 - c high titers of anti-smooth muscle antibodies
 - d high titers of antimitochondrial antibody
- 9 MLS ONLY Systemic lupus erythematosus patients with active disease often have which of the following test results?
- a high titers of antimicrosomal antibodies
 - b high titers of anti-smooth muscle antibodies
 - c marked decrease in serum CH_{50}
 - d decreased serum immunoglobulin levels
- 10 MLS ONLY Which of the following is **decreased** in serum during the active stages of systemic lupus erythematosus?
- a anti-nuclear antibody
 - b immune complexes
 - c complement (C3)
 - d anti-DNA
- 11 MLS ONLY A positive ANA with the pattern of anticentromere antibodies is **most** frequently seen in patients with:
- a rheumatoid arthritis
 - b systemic lupus erythematosus
 - c CREST syndrome
 - d Sjögren syndrome

- 12 MLS ONLY In the indirect fluorescent anti-nuclear antibody test, a homogenous pattern indicates the presence of antibody to:
- a RNP
 - b Sm
 - c RNA
 - d DNA
- 13 MLS ONLY In the indirect fluorescent anti-nuclear antibody test, a speckled pattern may indicate the presence of antibody to:
- a histone
 - b Sm
 - c RNA
 - d DNA
- 14 A patient has the following test results:
- | ANA | ASO | Complement | RA |
|----------|---------------|------------|----|
| +, 1:320 | 50 Todd units | decreased | + |
- The above results could be seen in patients with:
- a rheumatic fever
 - b rheumatoid arthritis
 - c lupus erythematosus
 - d glomerulonephritis
- 15 MLS ONLY Autoantibodies in the absence of Sm are found in patients with:
- a mixed connective tissue disease
 - b systemic lupus erythematosus
 - c Crohn disease
 - d multiple myeloma
- 16 To make a presumptive diagnosis of rheumatoid arthritis, which of the following qualitative methods is **most** sensitive?
- a latex agglutination
 - b immunoelectrophoresis
 - c RID
 - d ELISA
- 17 Rheumatoid factor reacts with:
- a inert substances such as latex
 - b Rh-positive erythrocytes
 - c kinetoplasts of *Crithidia luciliae*
 - d gamma globulin-coated particles
- 18 A consistently and repeatedly negative IFA-ANA is:
- a strong evidence against untreated SLE
 - b associated with active SLE
 - c characteristic of SLE with renal involvement
 - d associated with lupus inhibitor
- 19 Positive rheumatoid factor is generally associated with:
- a hyperglobulinemia
 - b anemia
 - c decreased erythrocyte sedimentation rate
 - d azotemia

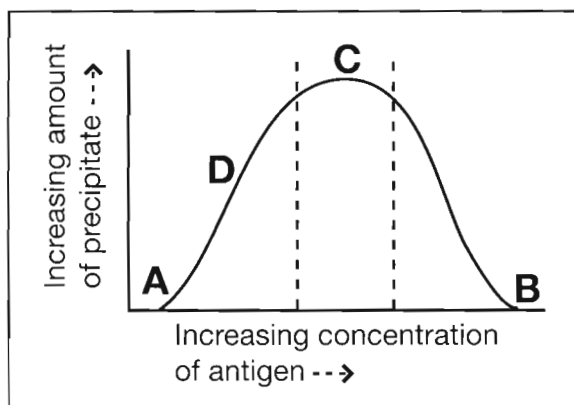
- 20 The following results are from a rubella titer performed on acute and convalescent sera using a 2-fold serial dilution:
- | | |
|---------------------------|---------|
| Date tested: | 1/23/04 |
| Acute serum titer: | 1:8 |
| Convalescent serum titer: | 1:32 |
- After evaluating the above results, the best interpretation is:
- a results are consistent with active infection with rubella
 - b variation in the acute serum titers invalidates these results
 - c test should be repeated by a different technologist
 - d patient was not infected with rubella
- 21 Rheumatoid factors are immunoglobulins with specificity for allotypic determinants located on the:
- a Fc fragment of IgG
 - b Fab fragment of IgG
 - c J chain of IgM
 - d secretory component of IgA
- 22 Rheumatoid factor in a patient's serum may cause a false:
- a positive test for the detection of IgM class antibodies
 - b negative test for the detection of IgM class antibodies
 - c positive test for the detection of IgG class antibodies
 - d negative test for the detection of IgG class antibodies
- 23 Rheumatoid factors are defined as:
- a antigens found in the sera of patients with rheumatoid arthritis
 - b identical to the rheumatoid arthritis precipitin
 - c autoantibodies with specificity for the Fc portion of the immunoglobulin (IgG) molecule
 - d capable of forming circulating immune complexes only when IgM-type autoantibody is present
- 24 MLS ONLY Tissue injury in systemic rheumatic disorders such as systemic lupus erythematosus is thought to be caused by:
- a cytotoxic T cells
 - b IgE activity
 - c deposition of immune complexes
 - d cytolytic antibodies
- 25 MLS ONLY False-positive rheumatoid factor in agglutination and nephelometric methods can be due to elevated levels of:
- a cryoglobulin
 - b histidine-rich-glycoprotein
 - c aspartame
 - d C1q
- 26 MLS ONLY An acute phase protein that binds to the membrane of certain microorganisms and activates the complement system is:
- a C-reactive protein
 - b tumor necrosis factor alpha
 - c neutrophils
 - d kinins
- 27 High titers of antimicrobial antibodies are **most** often found in:
- a rheumatoid arthritis
 - b systemic lupus erythematosus
 - c chronic hepatitis
 - d thyroid disease

- 28 MLS ONLY Which of the following is an organ-specific autoimmune disease?
- a myasthenia gravis
 - b rheumatoid arthritis
 - c Addison disease
 - d progressive systemic sclerosis
- 29 In chronic active hepatitis, high titers of which of the following antibodies are seen?
- a antimitochondrial
 - b anti-smooth muscle
 - c anti-DNA
 - d anti-parietal cell
- 30 MLS ONLY In primary biliary cirrhosis, which of the following antibodies is seen in high titers?
- a antimitochondrial
 - b anti-smooth muscle
 - c anti-DNA
 - d anti-parietal cell
- 31 Anti-RNA antibodies are often present in individuals having an anti-nuclear antibody immunofluorescent pattern that is:
- a speckled
 - b rim
 - c diffuse
 - d nucleolar
- 32 Anti-extractable nuclear antigens are **most** likely associated with which of the following anti-nuclear antibody immunofluorescent patterns?
- a speckled
 - b rim
 - c diffuse
 - d nucleolar
- 33 In an anti-nuclear antibody indirect immunofluorescence test, a sample of patient serum shows a positive, speckled pattern. Which would be the **most** appropriate additional test to perform?
- a antimitochondrial antibody
 - b immunoglobulin quantitation
 - c screen for Sm and RNP antibodies
 - d anti-DNA antibody using *C luciliae*
- 34 MLS ONLY Anti-glomerular basement membrane antibody is **most** often associated with this condition:
- a systemic lupus erythematosus
 - b celiac disease
 - c chronic active hepatitis
 - d Goodpasture disease
- 35 MLS ONLY A 25-year-old woman is seen by a physician because of Raynaud phenomenon, myalgias, arthralgias and difficulty in swallowing. There is no evidence of renal disease. An ANA titer is 1:5120 with a speckled pattern with mitotic. Which of the following are also likely to be found in this patient?
- a high-level nDNA antibody and a low CH₅₀ level
 - b high-level Sm antibody
 - c high-titer rheumatoid factor
 - d high-level ribonucleoprotein (RNP) antibody

- 36 MLS ONLY In pernicious anemia, which of the following antibodies is characteristically detected?
- a antimitochondrial
 - b anti-smooth muscle
 - c anti-DNA
 - d anti-parietal cell
- 37 MLS ONLY Anti-phospholipid antibodies associated with autoimmune disorders tend to have immunoglobulin (IgG) that belongs to which of the following subclasses?
- a IgG1 and IgG3
 - b IgG2 and IgG4
 - c IgG1 and IgG4
 - d IgG2 and IgG3
- 38 MLS ONLY The IIF staining pattern on ethanol-fixed leukocytes slides shows a perinuclear or nuclear staining pattern. This pattern is typically is due to:
- a C-ANCA
 - b LKM
 - c P-ANCA
 - d GBM
- 39 MLS ONLY The specificity of an immunoassay is determined by the:
- a label used on the antigen
 - b method used to separate the bound from free antigen
 - c antibody used in the assay
 - d concentration of unlabeled antigen
- 40 MLS ONLY In assessing the usefulness of a new laboratory test, sensitivity is defined as the percentage of:
- a positive specimens correctly identified
 - b false-positive specimens
 - c negative specimens correctly identified
 - d false-negative specimens
- 41 In the indirect immunofluorescence method of antibody detection, the labeled antibody is:
- a human anti-goat immunoglobulin
 - b rheumatoid factor
 - c goat anti-human immunoglobulin
 - d complement
- 42 Which of the following describes an antigen-antibody reaction?
- a the reaction is reversible
 - b the reaction is the same as a chemical reaction
 - c a lattice is formed at prozone
 - d a lattice is formed at postzone
- 43 The **most** common label in direct fluorescent antibody technique (DFA) is:
- a alkaline phosphatase
 - b horseradish peroxidase
 - c fluorescein isothiocyanate
 - d calcofluor white
- 44 A substrate is first exposed to a patient's serum, then after washing, anti-human immunoglobulin labeled with a fluorochrome is added. The procedure described is:
- a fluorescent quenching
 - b direct fluorescence
 - c indirect fluorescence
 - d fluorescence inhibition

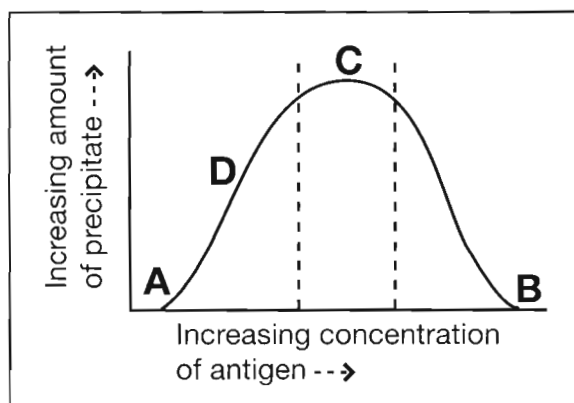
- 45 Avidity may be defined as the:
- a** degree of hemolysis
 - b** titer of an antigen
 - c** dilution of an antibody
 - d** strength of a reacting antibody
- 46 In the interpretation of agglutination tests for febrile diseases, which of the following is of the greatest diagnostic importance?
- a** anamnestic reactions caused by heterologous antigens
 - b** rise in titer of the patient's serum
 - c** history of previous vaccination
 - d** naturally occurring antibodies prevalent where the disease is endemic
- 47 Cholesterol is added to the antigen used in flocculation tests for syphilis to:
- a** destroy tissue impurities present in the alcoholic beef heart extract
 - b** sensitize the sheep RBCs
 - c** decrease specificity of the antigen
 - d** increase sensitivity of the antigen
- 48 The strength of a visible reaction is known as:
- a** prozone reaction
 - b** absorption
 - c** avidity
 - d** elution
- 49 Which of the following describes an antigen-antibody precipitation reaction of non-identity?
- a** precipitin lines cross, forming double spurs
 - b** precipitin lines fuse, forming a single spur
 - c** no precipitin lines are formed
 - d** precipitin lines fuse, forming a single arc
- 50 Which test has the greatest sensitivity for antigen detection?
- a** precipitin
 - b** agglutination
 - c** ELISA
 - d** complement fixation
- 51 Excess antigen in precipitation gel reactions will:
- a** have no effect on the precipitate reaction
 - b** not dissolve precipitate after formation
 - c** enhance the precipitate reaction
 - d** dissolve the precipitate after formation
- 52 Soluble immune complexes are formed under the condition of:
- a** antigen deficiency
 - b** antigen excess
 - c** antibody excess
 - d** complement
- 53 The visible serological reaction between soluble antigen and its specific antibody is:
- a** sensitization
 - b** precipitation
 - c** agglutination
 - d** opsonization

- 54 The curve below was obtained by adding increasing amounts of a soluble antigen to fixed volumes of monospecific antiserum:



The area on the curve for equivalence precipitate is:

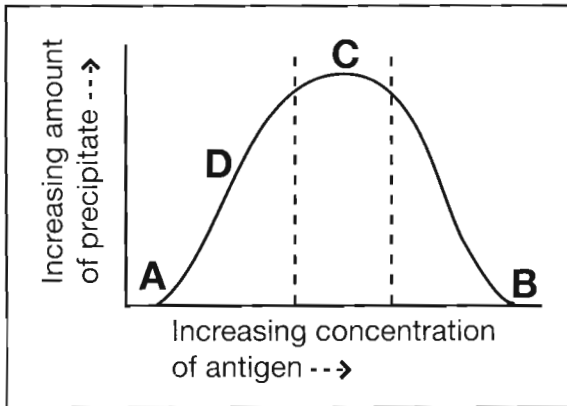
- a A
 - b B
 - c C
 - d D
- 55 The curve below was obtained by adding increasing amounts of a soluble antigen to fixed volumes of monospecific antiserum:



The area on the curve where no precipitate formed due to antigen excess is:

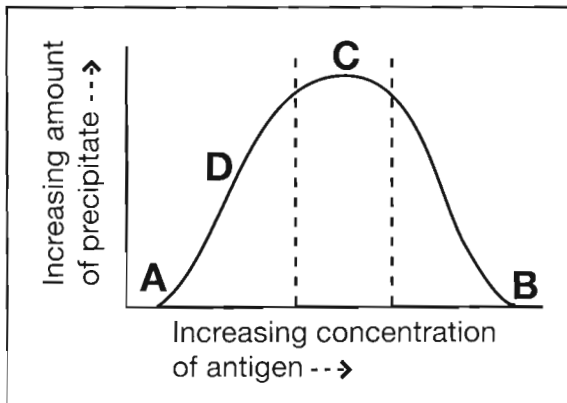
- a A
- b B
- c C
- d D

- 56 The curve below was obtained by adding increasing amounts of a soluble antigen to fixed volumes of monospecific antiserum:



The area on the curve for prozone is:

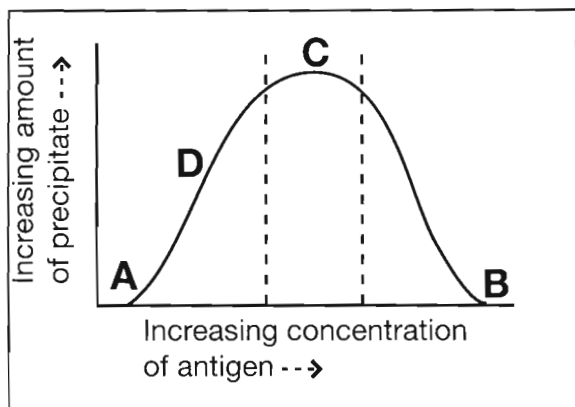
- a A
 - b B
 - c C
 - d D
- 57 The curve below was obtained by adding increasing amounts of a soluble antigen to fixed volumes of monospecific antiserum:



The area on the curve where soluble antigen-antibody complexes have begun to form is:

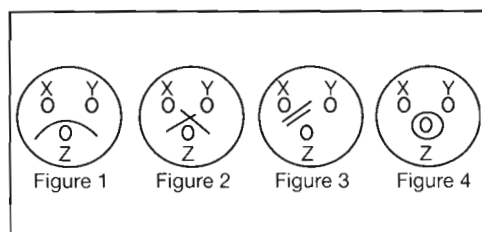
- a A
- b B
- c C
- d D

- 58 The curve below was obtained by adding increasing amounts of a soluble antigen to fixed volumes of monospecific antiserum:



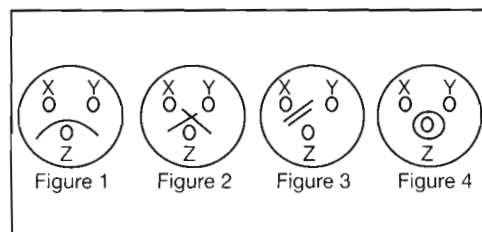
The area in which the addition of more antibody would result in the formation of additional precipitate is:

- a A
 - b B
 - c C
 - d D
- 59 Refer to the following illustration:



Which of the above figures demonstrates a reaction pattern of identity?

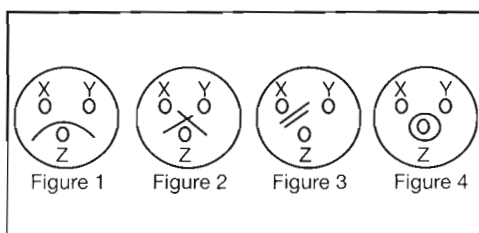
- a Figure #1
 - b Figure #2
 - c Figure #3
 - d Figure #4
- 60 Refer to the following illustration:



Which of the above figures demonstrates a reaction pattern of nonidentity?

- a Figure #1
- b Figure #2
- c Figure #3
- d Figure #4

61 Refer to the following illustration:

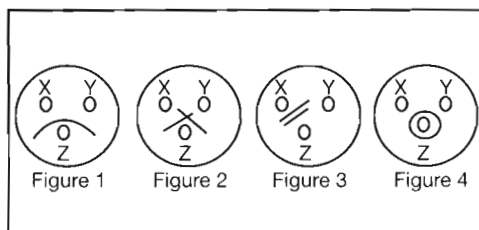


Which of the above figures demonstrates a reaction pattern showing 2 different antigenic molecular species?

- a Figure #1
- b Figure #2
- c Figure #3
- d Figure #4

62 Refer to the following illustration:

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A nonspecific precipitin reaction is demonstrated in:

- a Figure #1
- b Figure #2
- c Figure #3
- d Figure #4

63 A series of 8 tubes are set-up with 0.79 mL of diluent in each. A serial dilution is performed by adding 10 μ L of serum to the first tube and then transferring 10 μ L through each remaining tube. What is the serum dilution of tube 7?

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- a $1:2.431 \times 10^{11}$
- b $1:2.621 \times 10^{11}$
- c $1:1.920 \times 10^{13}$
- d $1:2.097 \times 10^{13}$

64 The enzyme control tube in an ASO hemolytic assay exhibits no cell lysis. What is the **most** likely explanation for this?

- a incorrect pH of buffer
- b low ionic strength buffer
- c oxidation of the enzyme
- d reduction of the enzyme

65 The following pattern of agglutination was observed in an antibody titration:

Tube	1	2	3	4	5	6	7	8	9	10	11
	1+	2+	4+	4+	3+	3+	2+	1+	1+	0	0

This set of reactions **most** likely resulted from:

- a faulty pipetting technique
 - b postzoning
 - c prozoning
 - d the presence of a high-titer, low-avidity antibody
- 66 In a **positive** anti-streptolysin "O" enzyme inhibition test, the patient's:
- a streptolysin "O" enzyme in the patient serum neutralizes the anti-streptolysin "O" reagent, resulting in no hemolysis
 - b red blood cells are hemolyzed by the streptolysin "O" enzyme in the reagent
 - c anti-streptolysin "O" neutralizes the streptolysin "O" reagent, resulting in hemolysis
 - d anti-streptolysin "O" inhibits the reagent streptolysin "O"s, resulting in no hemolysis

Infectious Disease Serology

- 67 Blood is drawn from a patient for serological tests for a viral disease at the time of onset and again 4 weeks later. The results of the tests are considered diagnostic if the:
- a first antibody titer is 2× the second
 - b first and second antibody titers are equal
 - c first antibody is 4× the second
 - d second antibody titer is at least 4× the first
- 68 Which of the following is **most** useful in establishing a diagnosis in the convalescence phase of a viral infection?
- a slide culture
 - b serological techniques
 - c shell vial
 - d culture on McCoy media
- 69 The best method to detect infections due to rubella, Epstein-Barr and human immunodeficiency viruses is:
- a antigen detection by EIA
 - b cell culture
 - c antigen detection by Western blot
 - d antibody detection by EIA
- 70 Immunoassays are based on the principle of:
- a separation of bound and free analyte
 - b antibody recognition of homologous antigen
 - c protein binding to isotopes
 - d production of antibodies against drugs
- 71 A DPT vaccination is an example of:
- a active humoral-mediated immunity
 - b passive humoral-mediated immunity
 - c cell-mediated immunity
 - d immediate hypersensitivity

72 Cells known to be actively phagocytic include:

- a neutrophils, monocytes, basophils
- b neutrophils, eosinophils, monocytes
- c monocytes, lymphocytes, neutrophils
- d lymphocytes, eosinophils, monocytes

73 The presence of HBsAg, anti-HBc and often HbeAg is characteristic of:

- a early acute phase HBV hepatitis
- b early convalescent phase HBV hepatitis
- c recovery phase of acute HBV hepatitis
- d past HBV infection

74 Refer to the following data:

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	HBsAg	anti-HBc IgM	anti-HAV IgM
patient #1	–	–	+
patient #2	+	+	–
patient #3	–	+	–

From the test results above, it can be concluded that patient #3 has:

- a recent acute hepatitis A
- b acute hepatitis B
- c acute hepatitis C (non-A/non-B hepatitis)
- d chronic hepatitis B

75 The disappearance of HBsAg and HBeAg, the persistence of anti-HBc, the appearance of anti-HBs, and often of anti-HBe indicate:

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- a early acute HBV hepatitis
- b early convalescent phase HBV hepatitis
- c recovery phase of acute HBV hepatitis
- d carrier state of acute HBV hepatitis

76 An example of an organ specific disease with autoimmune antibodies is:

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- a Wegener granulomatosis
- b rheumatoid arthritis
- c Hashimoto thyroiditis
- d systemic lupus erythematosus

77 When testing a patient for HIV antibody, which of the following is used to confirm a positive screening test?

- a radioimmunoassay
- b Western blot
- c immunofluorescence
- d ELISA

78 An example of a live attenuated vaccine used for human immunization is:

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- a rabies
- b tetanus
- c hepatitis B
- d measles

- 79 MLS ONLY A cold agglutinin titer end point is 1:16 after incubating overnight in the refrigerator and remains 1:16 after warming. The best course of action is to:
- report the titer as negative
 - report the titer as positive, 1:16
 - repeat the titer with a fresh sample
 - test for antibody specificity
- 80 What kind of antigen-antibody reaction would be expected if soluble antigen is added to homologous antibody?
- precipitation
 - agglutination
 - complement fixation
 - hemagglutination
- 81 The Rapid Plasma Reagin test:
- is useful in screening for syphilis
 - is useful in diagnosing syphilis
 - does not give false-positives
 - uses heated plasma
- 82 Flocculation tests for syphilis detect the presence of:
- reagin antibody
 - antigen
 - hemolysin
 - Forssman antigen
- 83 In the cold agglutinin test, the tubes containing the serum and erythrocytes are allowed to stand overnight in the refrigerator, and the results are read the next morning. If a disk of the erythrocytes floats up from the bottom of the tube with only the flick of finger, this is read as a:
- 4+ reaction
 - 2+ reaction
 - 1+ reaction
 - negative reaction
- 84 Flocculation tests for syphilis use antigen composed of:
- Treponema pallidum*
 - reagin
 - cardiolipin and lecithin
 - charcoal
- 85 The following cold agglutinin titer results are observed:

Tube #	1	2	3	4	5	6	7	8	9	10
dilution	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512
4°C	+	+	+	+	+	+	+	+	0	0
37°C	0	0	0	0	0	0	0	0	0	0

The best interpretation is:

- positive, 1:128
- negative
- invalid because 37°C reading is negative
- repeat the 4°C readings

- 86 A VDRL serum sample is heat inactivated, then placed in a refrigerator for overnight storage. Before being tested, the serum must be:
- a kept colder than 10°C
 - b allowed to equilibrate to room temperature
 - c warmed to 37°C
 - d reheated to 56°C for 10 minutes
- 87 Substances that are antigenic only when coupled to a protein carrier are:
- a opsonins
 - b haptens
 - c adjuvants
 - d allergens
- 88 A haptenic determinant will react with:
- MLS ONLY
- a both T cells and antibody
 - b T cells but not antibody
 - c neither T cells nor antibody
 - d antibody but not T cells
- 89 A serological test for syphilis that depends upon the detection of cardiolipin-lecithin-cholesterol antigen is:
- a FTA-ABS
 - b RPR
 - c MHA-TP
 - d TPI
- 90 The **most** important use of a nontreponemal antibody (NTA) test alone is in:
- MLS ONLY
- a establishing the diagnosis of acute active syphilis
 - b establishing the diagnosis of chronic syphilis
 - c evaluating the success of therapy
 - d determining the prevalence of disease in the general population
- 91 The serological test for syphilis recommended for detecting antibody in cerebrospinal fluid is:
- a nontreponemal antibody
 - b CSF-VDRL
 - c FTA-ABS
 - d MHA-TP
- 92 In the direct fluorescent antibody test for primary syphilis, spirochetes are detected by addition of labeled antibody to?
- MLS ONLY
- a *Treponema pallidum*
 - b cardiolipin
 - c human immunoglobulin
 - d nonpathogenic treponemes
- 93 In the FTA-ABS test, the presence of a beaded pattern of fluorescence along the treponeme indicates:
- MLS ONLY
- a positive identification of *Treponema pallidum*
 - b presumptive diagnosis of active syphilis
 - c presence of nontreponemal antibody (NTA)
 - d false-positive reaction
- 94 The FTA-ABS test for the serological diagnosis of syphilis is:
- MLS ONLY
- a less sensitive and specific than the VDRL if properly performed
 - b likely to remain positive after adequate antibiotic therapy
 - c currently recommended for testing cerebrospinal fluid
 - d preferred over darkfield microscopy for diagnosing primary syphilis

- 95 MLS ONLY A 16-year-old boy with infectious mononucleosis has a cold agglutinin titer of 1:2000. An important consideration of this antibody's clinical relevance is the:
- a thermal range
 - b titer at 4°C
 - c specificity
 - d light chain type
- 96 What assay would confirm the immune status to hepatitis B virus?
- a HBsAg
 - b anti-HBs
 - c IgM anti-HBcAg
 - d hepatitis C Ag
- 97 The following procedure has been routinely used for detection of hepatitis B surface antigen (HBsAg) because of its high level of sensitivity:
- a hemagglutination
 - b counterimmunoelectrophoresis
 - c radial immunodiffusion
 - d ELISA
- 98 In an indirect ELISA method designed to detect antibody to the rubella virus in patient serum, the conjugate used should be:
- a anti-human IgG conjugated to an enzyme
 - b anti-rubella antibody conjugated to an enzyme
 - c rubella antigen conjugated to an enzyme
 - d anti-rubella antibody conjugated to a substrate
- 99 MLS ONLY A request is received in the laboratory for assistance in selecting the appropriate test(s) for detecting Lyme disease. Which of the following would be suggested?
- a Stool culture should be done to isolate the causative organism.
 - b The organism is difficult to isolate, and antibody titers will provide the most help.
 - c *Borrelia burgdorferi* is easily isolated from routine blood cultures.
 - d This is an immunologic syndrome, and cultures are not indicated.
- 100 MLS ONLY A bacterial protein used to bind human immunoglobulins is:
- a HAV antibody, IgA type
 - b *Escherichia coli* protein C
 - c staphylococcal protein A
 - d HAV antibody, IgG type
- 101 Which of the following is the best indicator of an acute infection with the hepatitis A virus?
- a the presence of IgG antibodies to hepatitis A virus
 - b the presence of IgM antibodies to hepatitis A virus
 - c a sharp decline in the level of IgG antibodies to hepatitis A virus
 - d a rise in both IgM and IgG levels of antibody to hepatitis A virus
- 102 Biological false-positive VDRL reactions are frequently encountered in patients with:
- a lupus erythematosus
 - b acquired immune deficiency syndrome (AIDS)
 - c gonorrhea
 - d tertiary syphilis

- 103 Which serological marker of HBV (hepatitis B virus) infection indicates recovery and immunity?
- a viral DNA polymerase
 - b HBe antigen
 - c anti-HBs
 - d HBsAg

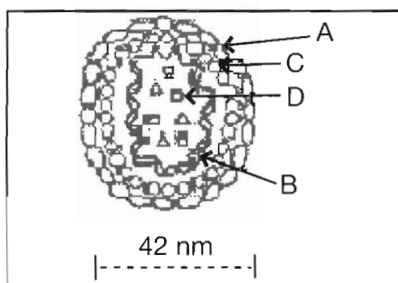
- 104 The profile that matches the typical test profile for chronic active hepatitis due to hepatitis B virus is:

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Profile	HBsAg	IgM anti-HBc	anti-HBc	anti-HBs
A	+	-	+	-
B	+	+	-	-
C	-	-	+	-
D	-	-	-	+

- a profile A
 - b profile B
 - c profile C
 - d profile D
- 105 For diagnosis of late latent or tertiary syphilis, the **most** appropriate assay is:
- a RPR
 - b VDRL
 - c FTA-ABS
 - d FTA-ABS IgM
- 106 A 26-year-old nurse developed fatigue, a low-grade fever, polyarthrititis and urticaria. Two months earlier she had cared for a patient with hepatitis. Which of the following findings are likely to be observed in this nurse?
- a a negative hepatitis B surface antigen test
 - b elevated AST and ALT levels
 - c a positive rheumatoid factor
 - d a positive Monospot™ test
- 107 The classic antibody response pattern following infection with hepatitis A is:
- a increase in IgM antibody; decrease in IgM antibody; increase in IgG antibody
 - b detectable presence of IgG antibody only
 - c detectable presence of IgM antibody only
 - d decrease in IgM antibody; increase in IgG antibody of the IgG3 subtype

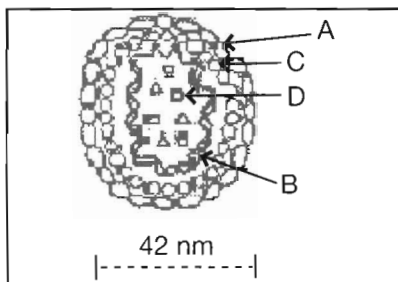
108 Refer to the following illustration of the hepatitis B virus:



Select the corresponding lettered component indicated on the diagram for surface antigen.

- a A
- b B
- c C
- d D

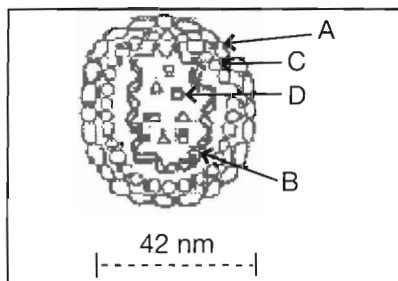
109 Refer to the following illustration of the hepatitis B virus:



Select the corresponding lettered component indicated on the diagram for e antigen.

- a A
- b B
- c C
- d D

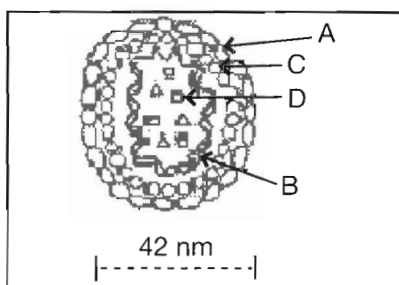
110 Refer to the following illustration of the hepatitis B virus:



Select the corresponding lettered component indicated on the diagram for core antigen.

- a A
- b B
- c C
- d D

111 Refer to the following illustration of the hepatitis B virus:



Select the corresponding lettered component indicated on the diagram for viral DNA.

- a A
- b B
- c C
- d D

112 The 20-nm spheres and filamentous structures of HBV are:

MLS
ONLY

- a infectious
- b circulating aggregates of HBcAg
- c circulating aggregates of HBsAg
- d highly infectious when present in great abundance

113 The enzyme-linked immunosorbent assay (ELISA) technique for the detection of HBsAg:

- a requires radiolabeled Clq
- b is quantitated by degree of fluorescence
- c uses anti-HBs linked to horseradish peroxidase
- d uses beads coated with HBsAg

114 The antigen marker **most** closely associated with transmissibility of HBV infection is:

- a HBsAg
- b HBeAg
- c HBcAg
- d HBV

115 Chronic carriers of HBV:

- a have chronic symptoms of hepatitis
- b continue to carry HBV
- c do not transmit infection
- d carry HBV but are not infectious

116 Hepatitis C differs from hepatitis A because it:

MLS
ONLY

- a has a highly stable incubation period
- b is associated with a high incidence of icteric hepatitis
- c is associated with a high incidence of the chronic carrier state
- d is seldom implicated in cases of posttransfusion hepatitis

117 The initial immune response following fetal infection with rubella is the production of which class(es) of antibodies?

- a IgG
- b IgA
- c IgM
- d both IgG and IgA

- 118 A maternal serum rubella titer that is equal to or greater than 1:8 indicates:
- a probable immunity to rubella
 - b evidence of acute rubella infection
 - c susceptibility to rubella infection
 - d absence of acute rubella
- 119 A false-negative cold agglutinin test may result if:
- MLS ONLY
- a the specimen is centrifuged at room temperature
 - b the cold agglutinin demonstrates anti-I specificity
 - c the specimen is refrigerated prior to serum separation
 - d adult human O red cells are used in the assay
- 120 Which of the following is a treponemal test?
- a RST
 - b RPR
 - c FTA-ABS
 - d VDRL
- 121 The air temperature throughout the serology laboratory is 20°C. How will this affect VDRL and RPR test results?
- a no effect—the acceptable test range is 20°-24°C
 - b weaken reactions so that false negatives occur
 - c strengthen reactions so that positive titers appear elevated
 - d increase the number of false positives from spontaneous clumping
- 122 Which laboratory technique is **most** frequently used to diagnose and follow the course of therapy of a patient with secondary syphilis?
- a flocculation
 - b precipitation
 - c complement fixation
 - d indirect immunofluorescence
- 123 A patient suspected of having toxoplasmosis has a specific IgG antibody titer of 1:64 upon initial testing. The titer of a second serum sample from the patient, taken 3 weeks later, was 1:256. These results are indicative of:
- MLS ONLY
- a past infection
 - b present infection
 - c allergic response
 - d recent vaccination
- 124 The **most** commonly used serological indicator of recent streptococcal infection is the antibody to:
- a streptolysin O
 - b hyaluronidase
 - c NADase
 - d DNA

Protein Analysis

- 125 Antibodies composed of IgG immunoglobulin:
- a occur during the primary response to antigen
 - b are larger molecules than IgM antibodies
 - c can cross the placenta from mother to fetus
 - d can be detected in saline crossmatches

- 126 Measurement of serum levels of which of the following immunoglobulins can serve as a screening test for multiple allergies?
- a IgA
 - b IgE
 - c IgG
 - d IgM
- 127 Cells that are precursors of plasma cells and also produce immunoglobulins are:
- a macrophages
 - b B lymphocytes
 - c T lymphocytes
 - d monocytes
- 128 IgM antibodies are frequently hemolytic because of:
- a their dimeric structure
 - b the molecule's 5 antigen binding sites
 - c their sedimentation coefficient of 7-15 S
 - d their efficient ability to fix complement
- 129 To which of the following classes do the antibodies that cause hemolytic disease of the newborn belong?
- a IgA
 - b IgE
 - c IgG
 - d IgD
- 130 It is important to note that when an infant is born, levels of specific antibody of the following class are used to indicate neonatal infection:
- a IgA
 - b IgG
 - c IgM
 - d IgD
- 131 MLS ONLY The immunoglobulin classes **most** commonly found on the surface of circulating B lymphocytes in the peripheral blood of normal persons are:
- a IgM, IgA
 - b IgM, IgG
 - c IgM, IgD
 - d IgM, IgE
- 132 Antibodies are produced by:
- a killer cells
 - b marrow stem cells
 - c mast cells
 - d B cells
- 133 Antibody class and antibody subclass are determined by major physiochemical differences and antigenic variation found primarily in the:
- a constant region of heavy chain
 - b constant region of light chain
 - c variable regions of heavy and light chains
 - d constant regions of heavy and light chains

- 134 The ratio of kappa to lambda light chain producing cells in normal individuals is:
MLS ONLY
- a 1:1
 - b 2:1
 - c 3:1
 - d 4:1
- 135 Which of the following immunoglobulin classes is associated with a secretory component (transport piece)?
- a IgA
 - b IgD
 - c IgE
 - d IgG
- 136 The immunoglobulin class typically found to be present in saliva, tears and other secretions is:
- a IgG
 - b IgA
 - c IgM
 - d IgD
- 137 Treatment of IgG with papain results in how many fragments from each immunoglobulin molecule?
- a 2
 - b 3
 - c 4
 - d 5
- 138 The immunoglobulin class associated with immediate hypersensitivity or atopic reactions is:
- a IgA
 - b IgM
 - c IgD
 - d IgE
- 139 Which of the following immunoglobulins is the **most** efficient at agglutination?
- a IgG
 - b IgA
 - c IgM
 - d IgE
- 140 Polyclonal B cell activation:
MLS ONLY
- a inhibits antibody production
 - b requires the participation of T helper cells
 - c results from the activation of suppressor T cells
 - d can induce autoantibody production
- 141 Antibodies to which of the following immunoglobulins is known to have produced anaphylactic reactions following blood transfusion?
MLS ONLY
- a IgA
 - b IgD
 - c IgE
 - d IgG
- 142 The key structural difference that distinguishes immunoglobulin subclasses is the:
- a number of domains
 - b stereometry of the hypervariable region
 - c the sequence of the constant regions
 - d covalent linkage of the light chains

- 143 Immunoglobulin idiotypic diversity is best explained by the theory of:
MLS ONLY
- a somatic mutation
 - b germ line recombination
 - c antigen induction
 - d clonal selection
- 144 Which of the following are true statements about selective IgA deficiency?
MLS ONLY
- a associated with a decreased incidence of allergic manifestations
 - b high concentration of secretory component in the saliva
 - c associated with an increased incidence of autoimmune diseases
 - d found in approximately 1 out of every 50 persons
- 145 Which class of immunoglobulin is thought to function as an antigenic receptor site on the surface of immature B lymphocytes?
MLS ONLY
- a IgD
 - b IgM
 - c IgA
 - d IgG
- 146 The IgM molecule is a:
- a dimer
 - b trimer
 - c tetramer
 - d pentamer
- 147 Which of the following immunoglobulins is present in the highest concentration in normal human serum?
- a IgM
 - b IgG
 - c IgA
 - d IgE
- 148 Which of the following statements about immunoglobulins is true?
- a immunoglobulins are produced by T lymphocytes
 - b IgA class is determined by the gamma heavy chain
 - c IgA class exists as serum and secretory molecules
 - d there are only 2 subclasses of IgG
- 149 Membrane-bound immunoglobulin molecules:
MLS ONLY
- a have an additional amino-terminal sequence of about 40 residues
 - b are not anchored in a transmembrane configuration
 - c are anchored by a hydrophobic sequence of about 26 residues
 - d are anchored by a hydrophilic region
- 150 The area of the immunoglobulin molecule referred to as the hinge region is located between which domains?
MLS ONLY
- a V_H and V_L
 - b C_{H1} and C_{H2}
 - c C_{H2} and C_{H3}
 - d C_{H3} and V_L
- 151 Antibody idiotype is dictated by the:
- a constant region of heavy chain
 - b constant region of light chain
 - c variable regions of heavy and light chains
 - d constant regions of heavy and light chains

- 152 Antibody allotype is determined by the:
- a** constant region of heavy chain
 - b** constant region of light chain
 - c** variable regions of heavy and light chains
 - d** constant regions of heavy and light chains
- 153 Which IgG subclass is **most** efficient at crossing the placenta?
- a** IgG1
 - b** IgG2
 - c** IgG3
 - d** IgG4
- 154 The J-chain is associated with which of the following immunoglobulins?
- a** IgA
 - b** IgG
 - c** IgE
 - d** IgD
- 155 The assembly of the complement “membrane attack unit” is initiated with the binding of:
- MLS ONLY
- a** C1
 - b** C3
 - c** C4
 - d** C5
- 156 Macrophages are characterized by:
- MLS ONLY
- a** surface receptors for C3b complement
 - b** surface CD3 expression
 - c** in vitro synthesis of immunoglobulin
 - d** large amounts of rough endoplasmic reticulum
- 157 Macrophage phagocytosis of bacteria is enhanced by which of the following:
- a** opsonin
 - b** antigen
 - c** hapten
 - d** secretory piece
- 158 Which of the following is **most** likely to activate the alternative pathway of complement activation?
- a** lipopolysaccharides
 - b** glycoproteins
 - c** haptens
 - d** IgG complexed with antigen
- 159 Which of the following is the larger residual split portion of C3?
- a** C3a
 - b** C3b
 - c** C4
 - d** Clq
- 160 Which of the following activities is associated with C3b?
- a** opsonization
 - b** anaphylaxis
 - c** vasoconstriction
 - d** chemotaxis

- 161 After a penicillin injection, a patient rapidly develops respiratory distress, vomiting and hives. This reaction is primarily mediated by:
- a IgG
 - b IgA
 - c IgM
 - d IgE
- 162 Which of the following is the “recognition unit” in the classical complement pathway?
- a C1q
 - b C3a
 - c C4
 - d C5
- 163 In immunofixation electrophoresis:
- a the antibody reacts with the antigen and then the complex is electrophoresed
 - b the antigen is electrophoresed into an antibody containing gel
 - c the antigen is electrophoresed and then monospecific antisera is reacted with it
 - d the antigen is electrophoresed, transferred to nitrocellulose and then antibody reacts with it and an EIA is performed
- 164 Which of the following is the “membrane attack complex” of complement activation?
- a C1
 - b C3
 - c C4, C2, C3
 - d C5b, C6, C7, C8, C9
- 165 Which of the following releases histamine and other mediators from basophils?
- a C3a
 - b properdin factor B
 - c Clq
 - d C4
- 166 The complement component C3:
- MLS ONLY
- a is increased (in plasma levels) when complement activation occurs
 - b can be measured by immunoprecipitin assays
 - c causes the conversion of C4 to C4a + C4b
 - d is not involved in the alternate complement pathway
- 167 The serum hemolytic complement level (CH₅₀):
- MLS ONLY
- a is a measure of total complement activity
 - b provides the same information as a serum factor B level
 - c is detectable when any component of the classical system is congenitally absent
 - d can be calculated from the serum concentrations of the individual components
- 168 A single, reliable screening test for detecting neonatal infection in the absence of clinical signs is:
- a serum immunoelectrophoresis
 - b differential leukocyte count
 - c CD4 cell counts
 - d quantitative serum IgM determination
- 169 Bence Jones proteins are:
- a immunoglobulin catabolic fragments in the urine
 - b monoclonal light chains
 - c whole immunoglobulins in the urine
 - d Fab fragments of a monoclonal protein

- 170** MLS ONLY A patient's serum IgA as measured by radial immunodiffusion (RID) was 40 mg/dL. Another laboratory reported IgA absent. A possible explanation for this discrepancy is that the:
- a** rabbit antiserum was used in the RID plates and rabbit antisera should not be utilized in RID assays
 - b** IgA has an Fc deletion that cause complex formation in vivo
 - c** IgA antiserum has kappa specificity
 - d** patient serum has antibodies against a protein in the antiserum in the agarose of the RID utilized by the first lab
- 171** MLS ONLY Goat anti-human IgG heavy chain specific alkaline phosphatase conjugate is a:
- a** monoclonal reagent that reacts with gamma heavy chains
 - b** monoclonal reagent that reacts with light chains
 - c** polyclonal reagent that reacts with gamma heavy chains
 - d** polyclonal reagent that reacts with light chains
- 172** Humoral antibodies are produced by which cells?
- a** macrophages
 - b** T lymphocytes
 - c** B lymphocytes
 - d** neutrophils
- 173** Initiation of the activation mechanism of the alternative complement pathway differs from that of the classical pathway in that:
- a** antigen-antibody complexes containing IgM or IgG are required
 - b** endotoxin alone cannot initiate activation
 - c** C1 component of complement is involved
 - d** antigen-antibody complexes containing IgA or IgE may initiate activation
- 174** Which of the following is cleaved as a result of activation of the classical complement pathway?
- a** properdin factor B
 - b** C1q
 - c** C4
 - d** C3b
- 175** The component associated only with the alternative pathway of complement activation is:
- a** C4
 - b** C1q
 - c** properdin factor B
 - d** C3a
- 176** MLS ONLY Which of the following complement components is a strong chemotactic factor as well as a strong anaphylatoxin?
- a** C3a
 - b** C3b
 - c** C5a
 - d** C4a
- 177** MLS ONLY The C3b component of complement:
- a** is undetectable in pathological sera
 - b** is a component of the C3 cleaving enzyme of the classical pathway
 - c** is cleaved by C3 inactivator into C3c and C3d
 - d** is not part of the alternative pathway

- 178 Components of the complement system **most** likely to coat a cell are:
MLS ONLY
- a C1 and C2
 - b C3 and C4
 - c C6 and C7
 - d C8 and C9
- 179 The serological test that can be modified to selectively detect only specific IgM antibody in untreated serum is:
MLS ONLY
- a Ouchterlony
 - b enzyme immunoassay
 - c hemagglutination inhibition
 - d passive hemagglutination
- 180 A patient's serum is being analyzed in a sandwich assay. This patient has received mouse monoclonal antibody therapy, and shows a false positive reaction in the sandwich assay, which is due to:
MLS ONLY
- a the mouse antibody in the patient's serum reacting to the antigen
 - b the presence of human anti-mouse antibody activity
 - c antibody to a mouse virus
 - d production of a monoclonal gammopathy of unknown significance after the antibody treatment
- 181 A monoclonal spike of IgG, Bence Jones proteinuria, and bone pain are usually associated with:
MLS ONLY
- a Burkitt lymphoma
 - b Bruton disease
 - c severe combined immunodeficiency disease
 - d multiple myeloma
- 182 The hyperviscosity syndrome is **most** likely to be seen in monoclonal disease of which of the following immunoglobulin classes?
MLS ONLY
- a IgA
 - b IgM
 - c IgG
 - d IgD
- 183 Patients suffering from Waldenström macroglobulinemia demonstrate excessively increased concentrations of which of the following?
MLS ONLY
- a IgG
 - b IgA
 - c IgM
 - d IgD
- 184 Which of the following is the **most** common humoral immune deficiency disease?
MLS ONLY
- a Bruton agammaglobulinemia
 - b IgG deficiency
 - c selective IgA deficiency
 - d Wiskott-Aldrich syndrome
- 185 Which of the following is a true statement about Bruton agammaglobulinemia?
MLS ONLY
- a it is found only in females
 - b there are normal numbers of circulating B cells
 - c there are decreased to absent concentrations of immunoglobulins
 - d the disease presents with pyogenic infections 1 week after birth

- 186** Immunodeficiency with thrombocytopenia and eczema is often referred to as:
- MLS ONLY
- a** DiGeorge syndrome
 - b** Bruton agammaglobulinemia
 - c** ataxia telangiectasia
 - d** Wiskott-Aldrich syndrome
- 187** The autosomal recessive form of severe combined immunodeficiency disease is also referred to as:
- MLS ONLY
- a** Bruton agammaglobulinemia
 - b** Swiss-type lymphopenic agammaglobulinemia
 - c** DiGeorge syndrome
 - d** Wiskott-Aldrich syndrome
- 188** In hybridoma technology, the desirable fused cell is the:
- MLS ONLY
- a** myeloma-myeloma hybrid
 - b** myeloma-lymphocyte hybrid
 - c** lymphocyte-lymphocyte hybrid
 - d** lymphocyte-granulocyte hybrid
- 189** Potent chemotactic activity is associated with which of the following components of the complement system:
- a** C1q
 - b** C5a
 - c** C3b
 - d** IgG
- 190** Hereditary angioedema is characterized by:
- a** decreased activity of C3
 - b** decreased activity of C1 esterase inhibitor
 - c** increased activity of C1 esterase inhibitor
 - d** increased activity of C2
- 191** Which of the following has been associated with patients who have homozygous C3 deficiency?
- a** undetectable hemolytic complement activity in the serum
 - b** systemic lupus erythematosus
 - c** no detectable disease
 - d** a lifelong history of life-threatening infections
- 192** Hereditary deficiency of early complement components (C1, C4 and C2) is associated with:
- a** pneumococcal septicemia
 - b** small bowel obstruction
 - c** lupus erythematosus like syndrome
 - d** gonococcemia
- 193** Hereditary deficiency of late complement components (C5, C6, C7 or C8) can be associated with which of the following conditions?
- a** pneumococcal septicemia
 - b** small bowel obstruction
 - c** systemic lupus erythematosus
 - d** a systemic gonococcal infection if exposed

- 194 For several months a 31-year-old woman has had migratory polyarthritides and a skin rash. Upon admission to the hospital, the following laboratory data were obtained:

	Patient	Reference range
leukocyte count:	$4.7 \times 10^3/\mu\text{L}$	$5.0\text{--}10.0 \times 10^3/\mu\text{L}$
differential:	normal	
serum hemolytic complement:	<22 U	80–150 U
ANA:	positive in a homogenous pattern	
rheumatoid factor test:	negative	
urinalysis:	protein 1+, occasional RBCs	

This patient's test results are consistent with:

- a dermatomyositis
 - b C1INH deficiency
 - c systemic lupus erythematosus
 - d mixed connective tissue disease
- 195 MLS ONLY Infantile X-linked agammaglobulinemia is referred to as:
- a Bruton agammaglobulinemia
 - b DiGeorge syndrome
 - c Swiss-type agammaglobulinemia
 - d ataxia telangiectasia
- 196 MLS ONLY Combined immunodeficiency disease with loss of muscle coordination is referred to as:
- a DiGeorge syndrome
 - b Bruton agammaglobulinemia
 - c ataxia telangiectasia
 - d Wiskott-Aldrich syndrome
- 197 MLS ONLY In skin tests, a wheal and flare development is indicative of:
- a immediate hypersensitivity
 - b delayed hypersensitivity
 - c anergy
 - d Arthus reaction
- 198 Which immunologic mechanism is usually involved in bronchial asthma?
- a immediate hypersensitivity
 - b antibody mediated cytotoxicity
 - c immune complex
 - d delayed hypersensitivity
- 199 Antihistamines like Benadryl®:
- a depress IgE production
 - b block antigen binding to surface IgE
 - c bind histamine
 - d block H₁ histamine receptors
- 200 MLS ONLY Which of the following is used to detect allergen specific IgE?
- a RIST
 - b IEP
 - c RAST
 - d CRP

- 201 A child has severe hay fever. A total IgE measurement was performed by the Ouchterlony immunodiffusion method. No lines of precipitation appeared on the immunodiffusion plate. The **most** likely explanation is:
- a IgE antibodies are not produced in children who have hay fever
 - b hay fever is mediated by the cellular system
 - c IgE is in too low a concentration to be detected by this method
 - d IgA is the antibody commonly produced in people with hay fever

Cellular Immunity and Histocompatibility Techniques

- 202 Which test is used to evaluate the cellular immune system in a patient?
- a skin test for commonly encountered antigens
 - b determination of isohemagglutinin titer
 - c immunoelectrophoresis of serum
 - d measurement of anti-HBsAg after immunization
- 203 T cells are incapable of:
- a collaborating with B cells in antibody responses
 - b secretion of immunoglobulins
 - c secretion of cytokines
 - d producing positive skin tests
- 204 T lymphocytes are incapable of functioning as:
- a cytotoxic cells
 - b helper cells
 - c phagocytic cells
 - d regulatory cells
- 205 Nonspecific killing of tumor cells is carried out by:
- a cytotoxic T cells
 - b helper T cells
 - c natural killer cells
 - d antibody and complement
- 206 Tumor markers found in the circulation are **most** frequently measured by:
- a immunoassays
 - b thin-layer chromatography
 - c high-pressure liquid chromatography
 - d colorimetry
- 207 A patient with a B-cell deficiency will **most** likely exhibit:
- a decreased phagocytosis
 - b increased bacterial infections
 - c decreased complement levels
 - d increased complement levels
- 208 A patient with a T-cell deficiency will **most** likely exhibit:
- a increased immune complex formation
 - b increased parasitic infections
 - c decreased IgE-mediated responses
 - d decreased complement levels

- 209 Which of the following is an important cellular mediator of immune complex tissue injury?
- a** mast cell
 - b** neutrophil
 - c** basophil
 - d** eosinophil
- 210 Which of the following mediators is released during T-cell activation?
- a** immunoglobulins
 - b** thymosin
 - c** serotonin
 - d** cytokines
- 211 MLS ONLY The HLA antibodies used in histocompatibility typing have been obtained from which of the following?
- a** multiparous women
 - b** nonidentical siblings
 - c** sheep blood
 - d** rabbit serum
- 212 Which of the following terms describes a graft between genetically unidentical individuals belonging to the same species?
- a** autograft
 - b** isograft
 - c** allograft
 - d** xenograft
- 213 MLS ONLY Incompatibility by which of the following procedures is an absolute contraindication to allotransplantation?
- a** MLC (mixed lymphocyte culture)
 - b** HLA typing
 - c** Rh typing
 - d** ABO grouping
- 214 MLS ONLY Which is a recognized theory of the origin of autoimmunity?
- a** enhanced regulatory T-cell function
 - b** diminished helper T-cell activity
 - c** production of antibodies that cross-react with tissue components
 - d** deficient B-cell activation
- 215 MLS ONLY C3b and Fc receptors are present on:
- a** B lymphocytes
 - b** monocytes
 - c** B lymphocytes and monocytes
 - d** neither B lymphocytes and monocytes
- 216 T lymphocytes that possess the CD8 surface marker mediate which of the following T-cell functions?
- a** delayed type hypersensitivity
 - b** regulatory
 - c** cytotoxic
 - d** helper

217 Delayed hypersensitivity may be induced by:

- a contact sensitivity to inorganic chemicals
- b transfusion reaction
- c anaphylactic reaction
- d bacterial septicemia

218 The **most** rapid immediate hypersensitivity reaction is associated with:

- a transfusion
- b anaphylaxis
- c contact dermatitis
- d serum sickness

219 The normal controls for a quantitative B lymphocyte assay should have a value of what percentage of total lymphocytes counted?

MLS
ONLY

- a 21%
- b 48%
- c 76%
- d 89%

220 An immunofluorescence test using reagent antibody directed against the CD3 surface marker would identify which of the following cell types in a sample of human peripheral blood?

- a all mature T lymphocytes
- b T helper lymphocytes only
- c cytotoxic T lymphocytes only
- d T regulatory cells only

221 Refer to the following results for peripheral blood samples:

MLS
ONLY

	% T lymphocytes
patient #1:	85%
patient #2:	23%
patient #3:	51%
patient #4:	82%
normal control:	44%

The data above indicates:

- a patient #1 has an abnormally high T lymphocyte count
- b patient #2 has a normal T lymphocyte count
- c patients #1 and #3 have normal T lymphocyte counts
- d the normal control is too low and another sample should be selected

222 Refer to the following flow cytometric data.

MLS
ONLY

absolute WBC:	8,930
total lymphocytes:	30%
B lymphocytes:	40%
T lymphocytes:	58%

Calculate the absolute count for B lymphocytes.

- a 1,072
- b 2,679
- c 3,572
- d 6,251

223 A concentrate of lymphocytes can be prepared from peripheral blood by:

MLS
ONLY

- a density gradient centrifugation
- b ultracentrifugation
- c zone electrophoresis
- d freeze fractionation

224 In flow cytometry, labeled cells:

- a scatter the light and absorb fluorescence
- b absorb fluorescence and emit electronic impulses
- c scatter the light and emit fluorescence
- d absorb both fluorescence and light

225 A marked decrease in the CD4 lymphocytes and decrease in the CD4/CD8 ratio:

- a is diagnostic for bacterial septicemia
- b may be seen in **most** hereditary immunodeficiency disorders
- c is associated with a viral induced immunodeficiency
- d is only seen in patients with advanced disseminated cancer

226 Refer to the following data from a peripheral blood sample:

MLS
ONLY

total WBC: $10.0 \times 10^3/\mu\text{L}$

Differential:

neutrophils:	68%
lymphocytes:	25% (40% T cells)
monocytes:	4%
eosinophils:	2%
basophils:	1%

The expected total number of T cells is:

- a 200
- b 1,000
- c 2,000
- d 2,500

227 A peripheral blood total leukocyte count is $10.0 \times 10^3/\mu\text{L}$. The differential reveals 55% neutrophils, 2% eosinophils, 40% lymphocytes and 3% monocytes. Assuming a lymphocyte recovery of 85%-95%, what is the expected number of T cells in a normal individual?

MLS
ONLY

- a 750/ μL
- b 2,500/ μL
- c 4,000/ μL
- d 8,000/ μL

228 In laser flow cytometry, applying a voltage potential to sample droplets as they stream past the light beam and using charged deflector plates results in:

MLS
ONLY

- a an emission of red fluorescence from cells labeled with fluorescein isothiocyanate
- b an emission of green fluorescence from cells labeled with rhodamine
- c a 90° light scatter related to cell size
- d the separation of cells into subpopulations based on their charge

229 What is the immunologic method utilized in the flow cytometer?

- a latex agglutination
- b enzyme linked immunoassay
- c immunofluorescence
- d radioimmunoassay

230 Given the following data:

WBC:	$5.0 \times 10^3/\mu\text{L}$
lymphs:	15%
CD4:	8%

Calculate the absolute CD4:

- a 40
- b 60
- c 400
- d 750

231 Given this hematologic data:

WBC:	$5.0 \times 10^3/\mu\text{L}$
lymphs:	15%
CD4:	8%

Which of the following is the correct interpretation?

- a CD4% and absolute CD4 normal
- b consistent with an intact immune system
- c consistent with a viral infection such as HIV
- d technical error

232 Bone marrow transplant donors and their recipients must be matched for which antigen system(s)?

MLS
ONLY

- a ABO-Rh
- b HLA
- c CD4/CD8
- d Pl^{a1}

233 A 28-year-old man is seen by a physician because of several months of intermittent low back pain. The patient's symptoms are suggestive of ankylosing spondylitis. Which of the following laboratory studies would support this diagnosis?

MLS
ONLY

- a a decreased synovial fluid CH_{50} level
- b low serum CH_{50} level
- c positive HLA-B27 antigen test
- d rheumatoid factor in the synovial fluid

234 Cells from a patient with hairy cell leukemia have immunologic and functional features of:

MLS
ONLY

- a mast cells and B lymphocytes
- b B lymphocytes and T lymphocytes
- c granulocytes and monocytes
- d B lymphocytes and monocytes

235 Which T-cell malignancy may retain "helper" activity with regard to immunoglobulin synthesis by B cells?

MLS
ONLY

- a Hodgkin lymphoma
- b acute lymphocytic leukemia (ALL)
- c Sézary syndrome
- d chronic lymphocytic leukemia (CLL)

236 A patient's abnormal lymphocytes are positive for CD2 antigen, lack C3 receptors, and are negative for surface immunoglobulin. This can be classified as a disorder of:

- a T cells
- b B cells
- c monocytes
- d natural killer cells

237 HLA typing of a family yields the following results:

MLS
ONLY

	Locus A	Locus B
father	(8, 12)	(17, 22)
mother	(7, 12)	(13, 27)

On the basis of these genotypes, predict the possibility of ankylosing spondylitis in this percentage of their children.

- a 25% of their children
- b 50% of their children
- c 75% of their children
- d 100%

238 HLA-B8 antigen has been associated with which of the following pairs of diseases?

MLS
ONLY

- a ankylosing spondylitis and myasthenia gravis
- b celiac disease and ankylosing spondylitis
- c myasthenia gravis and celiac disease
- d Reiter disease and multiple sclerosis

239 Which of the following is an important marker for the presence of immature B cells in patients with acute lymphocytic leukemia (ALL)?

MLS
ONLY

- a terminal deoxynucleotidyl transferase (TdT)
- b adenosine deaminase
- c glucose-6-phosphate dehydrogenase
- d purine nucleoside phosphorylase

1 b	59 a	117 c	175 c	233 c
2 c	60 b	118 a	176 c	234 d
3 c	61 c	119 c	177 c	235 c
4 c	62 d	120 c	178 b	236 a
5 a	63 d	121 b	179 b	237 b
6 b	64 c	122 a	180 b	238 c
7 a	65 c	123 b	181 d	239 a
8 a	66 d	124 a	182 b	
9 c	67 d	125 c	183 c	
10 c	68 b	126 b	184 c	
11 c	69 d	127 b	185 c	
12 d	70 b	128 d	186 d	
13 b	71 a	129 c	187 b	
14 c	72 b	130 b	188 b	
15 a	73 a	131 c	189 b	
16 a	74 b	132 d	190 b	
17 d	75 c	133 a	191 d	
18 a	76 c	134 b	192 c	
19 a	77 b	135 a	193 d	
20 a	78 d	136 b	194 c	
21 a	79 d	137 b	195 a	
22 a	80 a	138 d	196 c	
23 c	81 a	139 c	197 a	
24 c	82 a	140 d	198 a	
25 d	83 a	141 a	199 d	
26 a	84 c	142 c	200 c	
27 d	85 a	143 b	201 c	
28 c	86 d	144 c	202 a	
29 b	87 b	145 b	203 b	
30 a	88 d	146 d	204 c	
31 d	89 b	147 b	205 c	
32 a	90 c	148 c	206 a	
33 c	91 b	149 c	207 b	
34 d	92 a	150 b	208 b	
35 d	93 d	151 c	209 b	
36 d	94 b	152 d	210 d	
37 b	95 a	153 a	211 a	
38 c	96 b	154 a	212 c	
39 c	97 d	155 d	213 d	
40 a	98 a	156 a	214 c	
41 a	99 b	157 a	215 c	
42 a	100 c	158 c	216 d	
43 c	101 b	159 b	217 a	
44 c	102 a	160 a	218 b	
45 d	103 c	161 d	219 a	
46 b	104 a	162 a	220 a	
47 d	105 c	163 c	221 d	
48 c	106 b	164 d	222 a	
49 a	107 a	165 a	223 a	
50 c	108 a	166 b	224 c	
51 d	109 d	167 a	225 c	
52 b	110 c	168 d	226 b	
53 b	111 b	169 b	227 b	
54 c	112 c	170 d	228 d	
55 b	113 c	171 c	229 c	
56 a	114 b	172 c	230 b	
57 d	115 b	173 d	231 c	
58 b	116 c	174 c	232 b	

Autoantibody Evaluation

- 1 **b** ANA detects circulating antibodies to nuclear antigens in systemic rheumatic diseases.
[Detrick 2006, p995]
- 2 **c** The Crithidia substrate has giant mitochondrion containing native DNA that is free from contaminating histone antigens.
[Detrick 2006, p1028]
- 3 **c** Sm is characteristic of a speckled pattern.
[Detrick 2006, p996]
- 4 **c** Storage at 4°C is sufficient for samples analyzed up to a week after collection. For longer periods (months or years) -20 °C is preferable.
[Rose 2002, p926]
- 5 **a** Antigen target in the homogeneous pattern is DNA.
[Detrick 2006, p996]
- 6 **b** Homogeneous pattern may indicate the presence of anti-DNA antibodies for both single- or double-stranded DNA.
[Rose 2002, p923]
- 7 **a** Peripheral pattern reacts with the antigenic determinants of doublestrandedness of DNA.
[Miller 1991, pp314-315]
- 8 **a** Anti-DNA antibodies are prototypic autoantibodies found in the sera of SLE patients.
[Detrick 2006, p1027]
- 9 **c** CH50 is a good screening test for complement deficiencies in the classical pathway. In SLE patients the classical pathway is critical for immune complex clearance.
[Rose 2002, p914]
- 10 **c** C3 becomes depleted due to the autoantibody called C3-nephritic factor (C3NeF).
[Benjamin 2000, p273]
- 11 **c** A centromere is the specialized area of chromosome constriction during metaphase. Autoantibodies to centromere antigens are found in 22% of patients with progressive systemic sclerosis (PSS, or diffuse scleroderma) and in 90% of patients with the subset of scleroderma known as the CREST syndrome (calcinosis, Raynaud, esophageal dysfunction, sclerodactyly, and telangiectasia).
[Detrick 2006, pp996-997]
- 12 **d** The homogeneous/rim ANA pattern can be caused by: antibodies to double and single-stranded DNA (seen in SLE in high titers and in lower titers in other rheumatic diseases).
[Detrick 2006, p996]
- 13 **b** Sm antigen is a non-histone nuclear protein composed of several polypeptides of differing molecular weights. Sm causes a speckled pattern.
[Detrick 2006, p996]
- 14 **c** Systemic lupus is characterized by an association of autoantibody production; generalized multisystem.
[Detrick 2006, p1027]
- 15 **a** Systemic lupus erythematosus patients usually have Sm antibodies; patients with Crohn disease have centromere antibodies; patients with multiple myeloma have an increase in monoclonal antibodies.
[Rose 2002, p951]
- 16 **a** Latex test has low sensitivity; immunoelectrophoresis is not used; RID is not used; either ELISA or nephelometry has high sensitivity.
[Rose 2002, p68]
- 17 **d** Source for latex agglutination of RF is gamma globulin pools from humans, rabbits, or cattle.
[Detrick 2006, p1034]

- 18 a** Small percentage of normal healthy individuals and individuals with disorders not classified as autoimmune may have positive ANA. But positive ANA occurs most commonly in patients with systemic rheumatic diseases.
[Miller 1991, p340]
- 19 a** Hypergammaglobulinemia such as a polyclonal increase is associated with autoimmune disorders. Hypergammaglobulinemia such as a monoclonal increase is associated with such disease states as multiple myeloma, lymphomas, etc.
[Miller 1991, p98]
- 20 a** In a rubella infection, a titer of 1:8 or greater indicates protective antibodies. An acute infection would indicate a rise in titer between 2 serum samples collected 2 or more weeks apart.
[Miller 1991, pp314-315]
- 21 a** Antigen detected is located on the Fc portion of the IgG molecule.
[Detrick 2006, p1034]
- 22 a** IgM RF is the species most commonly measured in clinical assays.
[Detrick 2006, p1033]
- 23 c** Rheumatoid factor is an autoantibody to the Fc portion of the immunoglobulin molecule.
[Rose 2002, p923]
- 24 c** Large soluble complexes often accumulate along the basement membrane in the kidney. Impaired ability to process and clear immune complexes in SLE.
[Benjamin 2000, p273]
- 25 d** C1q like RF will bind and cross link IgG; Cryoglobulin—false negative.
[Rose 2002, p964]
- 26 a** Kinins act on smooth muscle; neutrophils are phagocytic cells; and TNF released by activated macrophages.
[Benjamin 2000, pp24-25]
- 27 d** TPO is positive for about 90% of patients with chronic thyroiditis.
[Detrick 2006, p1065]
- 28 c** Addison disease has antibodies circulating to adrenal antigens.
[Detrick 2006, p1065]
- 29 b** Chronic Active Hepatitis (CAH) has at least 2 subsets, the classic or type I, which is associated with a positive ANA test and positive smooth muscle antibodies. The condition is associated with an attack on the hepatocytes.
[Folds 1999, p161]
- 30 a** PBC is characterized by the presence of antimitochondrial antibodies.
[Detrick 2006, p1084]
- 31 d** Nucleolar pattern is characteristic of staining of the nucleolus seen as 1 or 2 large dots within each nucleus and is produced most frequently in the presence of antibody to nucleolar RNA.
[Miller 1991, p341]
- 32 a** Rnp/Sm extractable nuclear antigens show coarse nuclear speckles.
[Detrick 2006, p996]
- 33 c** Rnp/Sm extractable nuclear antigens show coarse nuclear speckles.
[Detrick 2006, p996]
- 34 d** Goodpasture syndrome is an autoimmune disease mediated by circulating autoantibodies with specificity to the GBM and the alveolar basement membrane.
[Detrick 2006, pp1110-1111]
- 35 d** Coarse nuclear speckles are seen in Raynaud syndrome. Autoantibodies, eg, anti-nRNP, are associated with certain symptoms such as Raynaud phenomenon.
[Rose 2002, p936]
- 36 d** Parietal cell antibodies are found in 90% of the cases with pernicious anemia. The other autoantibodies are not organ specific.
[Detrick 2006, pp1066-1067]
- 37 b** IgG2 and IgG4 are associated with autoimmune disorders; IgG1 and IgG3 are dominant in infections.
[Rose 2002, p974]

- 38** MLS ONLY **c** C-ANCA shows a granular cytoplasmic staining, and P-ANCA shows a perinuclear or nuclear staining pattern.
[Detrick 2006, p1056]
- 39** MLS ONLY **c** Specificity refers to the ability of an individual antibody combining site to react with only 1 antigenic determinant or the ability of a population of antibody molecules to react with only 1 antigen.
[O’Gorman 2008, p43]
- 40** MLS ONLY **a** The ratio of the true positives to the sum of true positives plus the false negatives.
[O’Gorman 2008, p43]
- 41** **a** Fluorochrome is a labeled anti-human immunoglobulin for indirect immunofluorescent assays.
[Miller 1991, p62]
- 42** **a** Antigen-antibody binding is governed by the law of mass action: free reactants are in equilibrium with bound reactants.
[Stevens 1996, p113]
- 43** **c** Fluorescein isothiocyanate fluoresces a visible green color when excited by UV.
[Benjamin 2000, p102]
- 44** **c** First react the target with an unlabeled antibody, then follow with a fluorescent dye.
[Benjamin 2000, p103]
- 45** **d** Describes the overall interaction of an antibody with its antigen.
[Detrick 2006, p10]
- 46** **b** A rising titer of antibody during the progression and resolution of an illness is an indication of infection with an organism.
[Gorbach 2003]
- 47** **d** VDRL antigen contains 0.9% cholesterol.
[Larsen 1998]
- 48** **c** Describes the overall interaction of an antibody with its antigen.
[Detrick 2006, p10]
- 49** **a** Non-identity: each antigen forms an independent precipitin line with the corresponding antibody at an equivalence point.
[Benjamin 2000, pp96-97]
- 50** **c** ELISA is a solid phase immunoassay that uses anti-immunoglobulins that are labeled with an enzyme that can be detected by the appearance of color on the addition of a substrate.
[Benjamin 2000, p101]
- 51** **d** Precipitation does not occur due to lack of free antibody.
[Rose 2002, p7]
- 52** **b** As more antigen is added, the reaction moves to antigen excess. Precipitation does not occur due to lack of free antibody. Upon the addition of antigen to a fixed quantity of antibody, immune complexes start forming immediately.
[Rose 2002, p7]
- 53** **b** Precipitation takes place when antibodies and soluble antigens are mixed.
[Benjamin 2000, p94]
- 54** **c** The proportion of antigen to antibody is optimal for maximal precipitation.
[Benjamin 2000, p95]
- 55** **b** Excess of antigen results in soluble complexes.
[Benjamin 2000, pp94-95]
- 56** **a** “Prozone—suboptimal precipitation occurs in the region of antibody excess. Prozone effect—Occasionally, it is observed that when the concentration of antibody is high (ie, lower dilutions), there is no agglutination and then, as the sample is diluted, agglutination occurs. The lack of agglutination at high concentrations of antibodies is called the *prozone effect*. Lack of agglutination in the prozone is due to antibody excess resulting in very small complexes that do not clump to form visible agglutination.”
[Benjamin 2000, pp94-95]
- 57** **d** Zone of antigen excess is depicted on the figure as D.
[Benjamin 2000, pp94-95]
- 58** **b** In the figure, B is the zone of antibody excess.
[Benjamin 2000, pp94-95]
- 59** **a** Continuous coalescing precipitin lines form when the 2 antigens are identical.
[Benjamin 2000, pp96-97]

- 60 **b** Two nonrelated antigens form independent precipitin lines that cross over each other.
[Benjamin 2000, pp96-97]
- 61 **c** Identity arc indicates that the 2 antigens are identical in figure #1. Figure #2, partial identity, shares a determinant that is part of antigen #1.
[Benjamin 2000, pp96-97]
- 62 **d** Identity arc indicates that the 2 antigens are identical in figure #1. Figure #2, partial identity, shares a determinant that is part of antigen #1.
[Benjamin 2000, pp96-97]
- 63 **d** A dilution involves the solute, the material being diluted and the diluent.
 $1/\text{dilution} = (\text{amount of solute})/(\text{total volume})$.
In the problem, the 8th tube is diluted.
[Stevens 1996, pp7-8]
- 64 **c** There should be complete hemolysis in the streptolysin O control tube.
[Miller 1991, p192]
- 65 **c** Prozone—suboptimal precipitation occurs in the region of antibody excess.
[Benjamin 2000, pp94-95]
- 66 **d** ASO is an enzyme inhibition test. In the ASO test, a serum results in inhibition of the reagent's enzymatic ability to lyse human red blood cells.
[Miller 1991, pp190-191]

Infectious Disease Serology

- 67 **d** A 4-fold or greater increase in antibody titer from 2 serum specimens taken from a patient during the acute and convalescent phases of an infection are considered to be diagnostic.
[Mahon 2006, p238]
- 68 **b** Cell culture methods are best used during the acute phase of a viral infection, when the viral titer is high. Serological techniques, which detect antibody to the virus, would be better in detecting viral infection during the convalescence phase, when the patient is recovering and the number of viral particles has decreased.
[Mahon 2006, pp831-834]

- 69 **d** Serological tests are commonly used to detect antibodies in infections with viruses that are difficult to culture, such as rubella, HIV, and EBV. EIA is a common serological method because it is sensitive, specific, and can be automated.
[Stevens 2003, p325]
- 70 **b** "Immunoassay" is a general term for an assay involving binding of an antibody to a specific antigen.
[Mahon 2006, p103]
- 71 **a** Vaccines stimulate the host to produce antibodies against a specific antigen to prevent disease.
[Kindt 2007, pp477-478]
- 72 **b** Lymphocytes and basophils are not phagocytic.
[Kindt 2007, pp34-37]
- 73 **a** The markers listed appear early during hepatitis B infection; HBsAg and HBeAg disappear prior to convalescence and recovery.
[Stevens 2003, pp327-328]
- 74 **b** IgM anti-HBc may be the only marker present during the "window period" between disappearance of HBsAg and the appearance of anti-HBs in late acute hepatitis B.
[Stevens 2003, pp327-328]
- 75 **c** Anti-HBs and anti-HBe are associated with recovery and development of immunity in hepatitis B, while HBsAg and HBeAg are antigens from HBV that are present during the infectious stages of disease.
[Stevens 2003, pp327-328]
- 76 **c** In Hashimoto disease, the auto-antibodies produced are specifically directed against the thyroid gland, whereas in the other diseases, they are not organ-specific.
[Mahon 2006, p139]
- 77 **b** Western blot has been the traditional confirmatory test for HIV antibody because it is very specific.
[Stevens 2003, pp357-358]
- 78 **d** To prevent measles, a vaccine consisting of live, weakened measles (rubeola) virus is used. The vaccine for rabies consists of killed rabies virus; the vaccine for tetanus is a toxoid; and the vaccine for hepatitis B is made up of a recombinant subunit.
[Goldsby 2003, p482]

- 79** MLS ONLY **d** Because the antibody is still reactive upon warming, a test for antibody specificity can help distinguish pathological from harmless autoantibodies.
[Rudman 2005, pp494-495]
- 80** **a** By definition, precipitation involves combination of antigen and soluble antibody to form insoluble complexes that fall out of solution.
[Stevens 2003, p129]
- 81** **a** The RPR is the most widely used nontreponemal test to screen for syphilis because it is rapid and inexpensive. It uses unheated serum to test for antibodies to cardiolipin, a lipid released during tissue damage in syphilis patients, but also present in other diseases with tissue damage.
[Stevens 2003, pp298-299]
- 82** **a** Flocculation is the aggregation of fine particles to form small clumps. This reaction occurs in nontreponemal tests for syphilis when reagin antibody reacts with the fine cardiolipin antigen particles.
[Stevens 2003, pp298-299]
- 83** **a** When 1 solid agglutinate is present, the reaction is classified as 4+.
[Blaney 2009, p161]
- 84** **c** Flocculation tests for syphilis are nontreponemal tests that detect antibody specific for cardiolipin antigen. When this antibody, called reagin, combines with the fine cardiolipin particles, small clumps are formed in a reaction called flocculation.
[Stevens 2003, p298]
- 85** **a** A cold agglutinin titer is read as the last dilution showing agglutination at 4°C.
[Miller 1991, p364]
- 86** **d** To avoid reactivation of complement, standard practice is to reheat the specimen for 10 minutes at 56°C if more than 4 hours has elapsed since the specimen was first inactivated.
[Miller 1991, p29]
- 87** **b** This is the definition of a hapten.
[Stevens 2003, p47]
- 88** MLS ONLY **d** In the immune response to a hapten-carrier complex, the hapten portion of the molecule binds to B cells, while the carrier portion binds to T cells, and the B cell is stimulated to produce hapten-specific antibody.
[Abbas 2007, pp225-226]
- 89** **b** Nontreponemal tests for syphilis, such as the RPR, detect antibody to cardiolipin antigen complexed with lecithin and cholesterol.
[Stevens 2003, p298]
- 90** MLS ONLY **c** Because of the high rate of false-positive results, nontreponemal tests cannot be used alone to establish a diagnosis of syphilis, but once the patient is known to have syphilis, they can be used to monitor therapy, since successful therapy will result in a decrease in the nontreponemal antibody titer.
[Stevens 2003, p298]
- 91** **b** The VDRL test is the only serological test recommended for testing of spinal fluid because of the low incidence of false positives.
[Stevens 2003, p299]
- 92** MLS ONLY **a** Direct detection of *T pallidum* organisms in lesions from patients with primary or secondary syphilis can be performed by dark-field microscopy or fluorescent antibody testing. In direct testing, labeled antibody that is specific for *T pallidum* binds directly to the spirochetes.
[Stevens 2003, pp297-298]
- 93** MLS ONLY **d** Serum from patients with lupus erythematosus may produce a false-positive result in the FTA-ABS test, which appears as a beaded pattern of fluorescence.
[Miller 1991, p213]
- 94** MLS ONLY **b** Once a patient shows reactivity in a treponemal test, such as the FTA-ABS, that patient will remain positive for life, regardless of whether or not they have received therapy.
[Stevens 2003, pp299-300]

- 95** MLS ONLY **a** It is important to determine the thermal range of reactivity, because cold antibodies are most likely to cause disease if they react with red blood cells at temperatures from 30°C to 32°C.
[Rudman 2005, pp494-495]
- 96** **b** Antibody to the surface antigen of hepatitis B virus (anti-HBs) is the major protective antibody in hepatitis B and provides evidence of immunity against this infection.
[Turgeon 2009, p283]
- 97** **d** Of all the methods listed, ELISA is the most sensitive and the only one that is used for detection of HBsAg in the clinical laboratory.
[Stevens 2003, p328]
- 98** **a** In an indirect ELISA, patient antibody to an antigen (eg, rubella antigen) is detected by addition of an enzyme-labeled antibody to human immunoglobulin, which, in turn, binds to the patient's IgG.
[Stevens 2003, p161]
- 99** MLS ONLY **b** It is difficult to isolate *Borrelia burgdorferi* from skin, blood, or other clinical samples; therefore, laboratory detection of Lyme disease is based on serological assays such as EIA, IFA, and Western blot.
[Stevens 2003, pp304-306]
- 100** MLS ONLY **c** Protein A, found in the cell walls of *Staphylococcus aureus* bacteria, has a high affinity for the Fc region of IgG, and can be used to bind IgG in some laboratory assays.
[Kindt 2007, pp162-164]
- 101** **b** IgM is the first antibody to be produced during an immune response, and levels decline within 6-12 months; it is therefore an indicator of a current infection.
[Stevens 2003, p326]
- 102** **a** Patients with the autoimmune disease, lupus erythematosus, frequently produce antibody against cardiolipin, the same antibody that is used to screen for syphilis by the VDRL test.
[Stevens 2003, p218]
- 103** **c** Antibody to the surface antigen of hepatitis B virus (anti-HBs) appears after the acute stage of infection during convalescence and is a marker of recovery and immunity, while the other markers listed are components of the virus itself.
[Turgeon 2009, p283]
- 104** MLS ONLY **a** HBsAg is an indicator of active infection, either acute or chronic. While IgM anti-HBc is present in acute infection, it disappears after this stage, while IgG antibody to the core antigen persists for life. Anti-HBs is an indicator of immunity, and this has not been achieved in chronic active hepatitis.
[Stevens 2003, pp327-328]
- 105** **c** Treponemal tests, such as the FTA-ABS, remain positive throughout the course of syphilis (except for IgM, which is only positive in the early stages), while nontreponemal tests are generally nonreactive in the late stages of disease.
[Turgeon 2009, p220]
- 106** **b** The nurse's history and symptoms suggest that she has hepatitis. The liver enzymes, alanine aminotransferase (ALT) and aspartate aminotransferase (AST) are elevated in hepatitis as general indicators of liver inflammation.
[Stevens 2003, p326]
- 107** **a** The immune response to HAV follows the classic pattern for an antibody response, with IgM appearing first, followed by a decline in IgM and appearance of IgG.
[Mahon 2006, p118]
- 108** **a** Hepatitis B surface antigen (HBsAg) is located in the outer envelope of the virus.
[Nester 2001, p610]
- 109** **d** Hepatitis Be antigen (HBeAg) is a soluble component in the core of the hepatitis B virus.
[Nester 2001, p610]
- 110** **c** The hepatitis B core antigen (HBc) is a protein in the nucleocapsid of HBV.
[Nester 2001, p610]
- 111** **b** Double-stranded DNA is present in the core of the virus.
[Nester 2001, p610]
- 112** MLS ONLY **c** These structures, which consist entirely of HBsAg, circulate in the serum but are not infectious since they lack the other viral components.
[Turgeon 2009, p282]
- 113** **c** The ELISA for HBsAg is a sandwich technique in which HBsAg in patient serum binds to anti-HBs on a solid phase; the HBsAg is then detected by the addition of an anti-HBs labeled with an enzyme.
[Stevens 2003, p328]

- 114 b** HBeAg is present in patient serum during periods of active HBV replication, and is therefore a marker of high infectivity. [Stevens 2003, p327]
- 115 b** Some patients who become infected with HBV do not develop immunity and become long-term carriers of the virus who can transmit the infection to others. [Turgeon 2009, pp284-285]
- 116 c** About 85% of persons infected with HCV will develop a chronic infection, while hepatitis A does not progress to a chronic state. [Stevens 2003, pp326, 329]
- 117 c** IgM is the first immunoglobulin to be produced during an immune response, and is produced by infants with congenital infections. IgG in the blood of a newborn infant is primarily of maternal origin, since it can cross the placenta, while IgA would be acquired through mother's breast milk. [Turgeon 2009, p302]
- 118 a** In serological assays for rubella, a titer of 1:8 or greater indicates presence of protective antibodies. An acute infection would be indicated by a rise in antibody titer between 2 serum samples collected 2 or more weeks apart, while susceptibility to rubella would be indicated by a negative antibody result. [Turgeon 2009, pp301-302]
- 119 c** Prior to collecting serum for the cold agglutinin test, blood must be warmed; refrigeration would result in the binding of the patient's cold agglutinin antibodies to his/her own red blood cells prior to the collection of serum, resulting in depletion of these antibodies from the serum, and a false-negative result when that serum is incubated with the human type O red blood cells used in the test. [Miller 1991, pp363-364]
- 120 c** The only treponemal test listed is the FTA-ABS (fluorescent treponemal antibody absorbed test), while the others are all nontreponemal tests that detect antibody to cardiolipin. [Stevens 2003, pp298-299]
- 121 b** It is recommended that the VDRL and RPR tests be performed at a temperature range between 23°C and 29°C; optimal agglutination does not occur at temperatures below that range, resulting in false negative tests. [Turgeon 2009, pp219-222]
- 122 a** Nontreponemal tests are used to screen for syphilis and monitor syphilis patients during therapy. These tests, the VDRL and RPR, are based on the principle of flocculation, created by the clumping of the fine cardiolipin particles used in the tests, after binding to patient's antibody. [Stevens 2003, p298]
- 123 b** A 4-fold or greater increase in antibody titer between 2 serum samples taken from the same patient over time indicates a current infection. [Stevens 2003, p373]
- 124 a** Patients with recent streptococcal infections produce antibodies to several enzymes produced by Streptococcal bacteria. The antibodies detected most commonly in the laboratory are those directed against streptolysin O or DNase B. [Stevens 2003, p316]

Protein Analysis

- 125 c** Biological functions of immunoglobulins; IgG crosses the placenta. [Stevens 2003, p64]
- 126 b** Biological functions of immunoglobulins; IgE is the antibody involved in multiple allergies. [Stevens 2003, p67]
- 127 b** Biological functions of lymphocytes; B cells make antibody, become plasma cells. [Stevens 2003, p31]
- 128 d** Biological functions of immunoglobulins; IgM binds complement well and is hemolytic. [Stevens 2003, p65]
- 129 c** Biological functions of immunoglobulins; IgG antibody crosses the placenta and is involved in hemolytic disease of the newborn. [Stevens 2003, p201]
- 130 b** Babies' IgG comes from their mother, but if they have elevated IgM, an in utero, or neonatal infection is indicated. [Stevens 2003, p64]
- 131 c** IgM and IgD are the classes of immunoglobulin that are found on most circulating B cells. They are in effect the B-cell receptor. [Stevens 2003, p31]

- 132 d** The function of B cells is to produce antibodies.
[Stevens 2003, p29]
- 133 a** The area on the immunoglobulin molecule that is the antigen-specific region is the Fab region (this is the amino terminal end). *Fab* stands for *fragment antigen binding*, and indicates a fragment after papain cleavage. The biological function of the immunoglobulin, ie, whether it goes to the placenta, whether it binds complement, and what effector cells it binds, resides in the Fc region, on the carboxy terminal end. The *Fc* stands for *fragment crystallizable*, and indicates the part of the immunoglobulin molecule after papain cleavage that has structural identity, and thus can be crystallized.
[Stevens 2003, ch5 p.61]
- 134 b** The immunoglobulin molecule is made up of one or more units (# of units depending on heavy chain type) composed of 2 heavy chains and 2 light chains. The light chains can be either the kappa or lambda type. About 65% of the human immunoglobulin molecules have kappa chains and 35% have lambda chains.
[Turgeon 2009, p20]
- 135 a** A secretory IgA molecule is composed of 2 units of 2 heavy chains and 2 light chains. These chains are joined by the J chain, and are protected from the harsher environment where there are secreted by an additional chain called the secretory piece.
[Stevens 2003, ch5]
- 136 b** Immunoglobulin A (IgA) is the most abundant immunoglobulin in saliva, tears, and other mucosal secretions and plays an important role in mucosal immunity.
[Stevens 2003, p66]
- 137 b** The area on the immunoglobulin molecule that is the antigen-specific region is the Fab region (called the amino terminal end). *Fab* stands for *fragment antigen binding*, and indicates a fragment after papain cleavage. The biological function of the immunoglobulin, ie, whether it goes to the placenta, whether it binds complement, and what effector cells it binds, resides in the Fc region, on the carboxy terminal end. The *Fc* stands for *fragment crystallizable*, and indicates the part of the immunoglobulin molecule after papain cleavage that has structural identity, and thus can be crystallized.
[Stevens 2003, p61]
- 138 d** Immunoglobulin function; IgE is the immunoglobulin involved with allergy.
[Stevens 2003, p68]
- 139 c** Immunoglobulin function; IgM best at agglutination.
[Stevens 2003, p65]
- 140 d** Autoimmunity, theories of how it develops.
[Stevens 2003, p213]
- 141 a** Immunoglobulin deficiency, patients with IgA deficiency can have an anaphylactic reaction during transfusions.
[Stevens 2003, p251]
- 142 c** Immunoglobulin subclasses differ from each other in their Fc regions; this is the reason that the different classes have different biological function. The Fc region is the region that is crystallizable after papain cleavage. It varies in sequence in the different classes of immunoglobulin.
[Stevens 2003, pp61-62]
- 143 b** The diversity sequence of the variable region, which is expressed as many idiotypic differences, is what allows so many different antigens to be bound by antibody. This huge diversity in the variable region develops due to VDJ recombinant events for the heavy chain and VJ recombinant events for the light chain.
[Stevens 2003, p69]
- 144 c** Immunoglobulin deficiency, IgA deficiency is related to autoimmune diseases.
[Stevens 2003, ch16 p251]

- 145 b** The main function of IgD is in B cell development; it is the class of surface immunoglobulin on immature B cells. [Stevens 2003, p31]
- 146 d** Immunoglobulin structure; IgM is a pentamer. [Stevens 2003, p65]
- 147 b** IgG highest in concentration in normal sera. [Stevens 2003, p64]
- 148 c** Immunoglobulin structure; IgA is in serum and secretions. [Stevens 2003, p66]
- 149 c** IgD and surface IgM are anchored in the B cell membrane; in order to be anchored in the membrane, they must contain a hydrophobic region. The hydrophobic region is about 26 residues long. [Stevens 2003, p64]
- 150 b** Immunoglobulin structure, hinge is between CH1 and CH2. [Stevens 2003, p62]
- 151 c** Immunoglobulin structure, idiotype is in variable regions of heavy and light chains. [Stevens 2003, p62]
- 152 d** Immunoglobulin allotype is in constant regions of heavy and light chains. [Stevens 2003, p62]
- 153 a** Immunoglobulin IgG subclass function, IgG1 goes through placenta best. [Stevens 2003, p63]
- 154 a** Immunoglobulin structure, J chain associated with IgA. [Stevens 2003, p66]
- 155 d** Complement, the membrane attack unit begins with C5. [Stevens 2003, p96]
- 156 a** Macrophages have surface receptors for C3b. [Stevens 2003, p96]
- 157 a** Macrophage phagocytosis enhanced by opsonins. [Stevens 2003, p13]
- 158 c** Haptens initiate the alternative pathway of complement. [Stevens 2003, p97]
- 159 b** C3 breaks down to a small C3a, which floats away and is an anaphylatoxin, and the larger C3b, which lands on the target surface and becomes part of C5 convertase, is also a powerful opsonin. [Stevens 2003, p94]
- 160 a** C3 breaks down to a small C3a, which floats away and is an anaphylatoxin, and the larger C3b, which lands on the target surface and becomes part of C5 convertase, is also a powerful opsonin. [Stevens 2003, p96]
- 161 d** Biological functions of immunoglobulins, IgE mediates immediate type hypersensitivity seen in penicillin allergy. [Stevens 2003, p68]
- 162 a** Complement C1q is the recognition piece. [Stevens 2003, p94]
- 163 c** In immunoelectrophoresis, first the serum is separated in an agarose gel by electrophoresis, then in a trough that is cut parallel to the plane of the electrophoresis, antiserum is placed. The antibody diffuses toward the serum proteins and arcs of antibody antigen precipitation occur. [Stevens 2003, p95]
- 164 d** Complement, C5 - C9, is the membrane attack unit. [Stevens 2003, p6]
- 165 a** C3a, C4a and C5a are anaphylatoxins and cause release of histamine from basophils and mast cells. [Stevens 2003, ch7]
- 166 b** Complement, C3 can be measured by RID. [Stevens 2003, ch7]
- 167 a** Complement, definition of the CH50 reaction. [Stevens 2003, ch7]
- 168 d** Babies' IgG comes from their mother, but if they have elevated IgM, an in utero, or neonatal infection is indicated. [Stevens 2003, ch5]
- 169 b** Definition of Bence Jones protein. [Stevens 2003, ch15]

170 d An radioimmunodiffusion assay measures the precipitin reaction of an antibody with an antigen. Normally the antibody in the gel reacts with an antigen diffusing from a well. If, however, the patient has an antibody to a protein in the antiserum, then the ring of precipitation that is measured can be the patient's immunoglobulin diffusing out of the well, and reacting with a serum antigen.
[Stevens 2003]

171 c A gamma-specific antibody would react only to the gamma heavy chain, not to the light chains or it would react with all classes of antibody. Monoclonal antibodies will usually say monoclonal in their name, and these are usually of mouse origin. Although rat monoclonal and rabbit monoclonal antibodies have been made, these are rarely used.
[Stevens 2003, p11]

172 c B cells make humoral antibodies.
[Stevens 2003, p31]

173 d IgA and IgE do not initiate the classical pathway of complement but can initiate the alternative pathway.
[Stevens 2003, ch7]

174 c Classical complement pathway: C1 is activated by binding 2 Fcs of immunoglobulin, then C4 is split to C4a and C4b; C4b binds, and next C2 is bound and cleaved; this forms C3 convertase, so C3 binds and is cleaved; C3b stays bound; C3a floats away; C5 next is split and C5b binds and C5a floats away. C6, C7, C8, and C9 bind sequentially and cause a hole in the membrane.
[Stevens 2003, ch7]

175 c Classical complement pathway (see answer 174); alternative pathway: C3 + Factor B → iC3B + Factor D and Mg++ → C3Bb or C3bBb; this is stabilized by properdin to make C3bBbC3bP, which is a C5 convertase, and C5 is split to C5a and C5b, and next C6, C7, C8 and C9 are activated and form a hole in the cell.
[Stevens 2003, ch7]

176 c C5a is both chemotactic and an anaphylatoxin.
[Stevens 2003, ch7]

177 c C3 is a very powerful amplifying step of the classical and alternative pathways and also forms a powerful opsinogen. Thus it must be subject to controls, and one such control is that it can be broken down to C3c and C3d.
[Stevens 2003, ch7]

178 b Conversion of C4 to C4a + C4b is an amplifying step with 30 molecules of C4 for every molecule of C1; C3 conversion is a large amplifying step with about 200 molecules converted for every C3 convertase. These extra molecules can bind to the cell surface.
[Stevens 2003, ch7]

179 b Indirect labeled assays can be designed to utilize class specific anti-human immunoglobulin, that is IgM specific.
[Stevens 2003, p11]

180 b Patients that have received mouse monoclonal antibody therapy may have a false-positive when tested with a sandwich assay due to the mouse monoclonal IgM utilized in the assay to test for a hepatitis B surface antigen.
[Abbott 2008]

181 d Multiple myeloma shows a monoclonal IgG spike in serum protein electrophoresis and light chains in the urine called Bence Jones protein. In addition, the tumor cells can grow in the bone forming round lesions that are very painful.
[Stevens 2003, p15]

182 b Waldenström macroglobulinemia is a monoclonal gammopathy in which the tumor cells are making IgM. The uncontrolled secretion of such a high molecule weight compound causes a severe increase in viscosity.
[Stevens 2003, p15]

183 c Waldenström macroglobulinemia is a monoclonal gammopathy in which the tumor cells are making IgM. The uncontrolled secretion of such a high molecule weight compound causes a severe increase in viscosity.
[Stevens 2003, p15]

184 c Selective IgA deficiency is the most common immunodeficiency.
[Stevens 2003, p15]

185 c Bruton agammaglobulinemia is an X-linked disease (therefore, usually found in males) in which there is a decreased immunoglobulin concentration, which becomes apparent at 2-6 months of age, ie, after the infant's maternally-transferred immunoglobulin has decreased due to its biological half-life. Problem is in differentiation at the pre-B cell stage.

[Stevens 2003, p15]

186 d Wiskott-Aldrich syndrome is an X-linked recessive defect that exhibits immunodeficiency, eczema and thrombocytopenia.

[Stevens 2003, p15]

187 b Swiss-type agammaglobulinemia is a type of severe combined immunodeficiency disease (SCID) that is autosomal recessive.

[Stevens 2003, p15]

188 b Monoclonal antibodies are produced by cells that are a fused hybrid of a mouse spleen cell with a mouse myeloma cell. The spleen cell confers the antibody specificity, and the tumor cells give it the ability to keep reproducing.

[Stevens 2003, pp70-72]

189 b C5a is a chemotaxin for neutrophils, basophils, mast cells and monocytes.

[Stevens 2003, p102]

190 b C1 esterase inhibitor is associated with hereditary angioedema.

[Stevens 2003, p104]

191 d C3 deficiency is the worst deficiency to have; it causes a lifelong history of life-threatening infections.

[Stevens 2003, p104]

192 c C1, C4, C2 deficiencies are associated with a lupus erythematosus-like syndrome.

[Stevens 2003, p104]

193 d C5, C6, C7, C8 deficiencies associated with a worse *Neisseria* infection if the patient is exposed due to less pathogen clearance.

[Stevens 2003, ch7 p104]

194 c C2 deficiency is associated with a lupus like syndrome.

[Stevens 2003, p104]

195 a X-linked infantile agammaglobulinemia is Bruton agammaglobulinemia; DiGeorge syndrome is a T-cell deficiency; Swiss-type is a SCID; ataxia has additional muscular coordination problems.

[Stevens 2003, p251]

196 c X-linked infantile agammaglobulinemia is Bruton agammaglobulinemia; DiGeorge syndrome is a T-cell deficiency; Swiss-type is a SCID; ataxia has additional muscular coordination problems.

[Stevens 2003, p255]

197 a Immediate hypersensitivity is tested by skin tests with edema and erythema, which also can be called wheal and flare.

[Stevens 2003, p198]

198 a Immediate hypersensitivity is involved in bronchial asthma.

[Stevens 2003, p197]

199 d Antihistamines block histamine binding to histamine receptors.

[Stevens 2003, p197]

200 c RAST tests for allergen specific IgE.

[Stevens 2003, p199]

201 c IgE is in too low a concentration for precipitation; therefore it cannot be detected by this method.

[Stevens 2003, p133]

Cellular Immunity and Histocompatibility Techniques

202 a Skin tests are used to determine whether the delayed type hypersensitivity response mediated by T cells is functioning properly. All other tests listed evaluate humoral antibody responses.

[Stevens 2003, pp256-257]

203 b While T cells help B cells in the process of antibody production, they are not capable of secreting immunoglobulins themselves. Immunoglobulins are produced only by B cells and plasma cells.

[Turgeon 2009, p55]

204 c Phagocytosis is mediated by macrophages and neutrophils, not by lymphocytes.

[Turgeon 2009, p31]

205 c Natural killer cells do not specifically bind to tumor antigens, as do T lymphocytes and antibodies, and can kill tumor cells without having had prior exposure to them.

[Stevens 2003, pp35-36]

- 206 a** Immunoassays that employ monoclonal antibody reagents are commonly used to quantify circulating tumor antigens because they are highly sensitive and specific.
[Bishop 2005, p609]
- 207 b** Antibodies are important in defense against bacterial infections. Patients with B-cell deficiencies are unable to produce adequate amounts of antibodies, and therefore exhibit increased bacterial infections. Also, B cells are not phagocytic and do not produce complement.
[Stevens 2003, p249]
- 208 b** T cells and cell-mediated immunity are important in defense against intracellular pathogens such as viruses, fungi, and parasites. Patients with T-cell deficiencies will therefore exhibit increased parasitic infections.
[Stevens 2003, p249]
- 209 b** The tissue damage resulting from type III hypersensitivity is caused by the deposition of immune complexes, which recruit neutrophils to the tissues. The neutrophils release their lysosomal enzymes, resulting in inflammation and damage to the surrounding tissues.
[Mahon 2006, pp95-96]
- 210 d** While B cells are involved in humoral immunity through the production of antibodies, T cells mediate their responses through the release of soluble proteins called cytokines.
[Turgeon 2009, p63]
- 211 a** MLS ONLY Multiparous women, or those having multiple children, frequently produce antibodies to fetal HLA antigens, which are of paternal origin. The serum from these women has therefore been used as a source for the HLA antibodies that are employed in the complement-dependent cytotoxicity test to type HLA antigens.
[Mahon 2006, p279]
- 212 c** By definition, an allograft is a graft between genetically unidentical individuals of the same species. An isograft is between genetically identical individuals, a xenograft is between individuals of different species, and an autograft is transplanted from 1 location to another in the same individual.
[Turgeon 2009, p432]
- 213 d** MLS ONLY ABO incompatibility results in hyperacute rejection. This reaction is mediated by anti-A or anti-B antibodies that naturally occur in individuals who lack the corresponding A or B antigen.
[Stevens 2003, p265]
- 214 c** MLS ONLY The theory of molecular mimicry states that antibodies produced against foreign antigens, such as certain microorganisms, can cross-react with self antigens to produce autoimmunity. All the other answers are incorrect because they would result in a decreased immune response.
[Turgeon 2009, pp367-368]
- 215 c** MLS ONLY Receptors for the C3b component of complement and for the Fc portion of immunoglobulin are found both on B cells and on monocytes, and are thought to play a role in the clearance of immune complexes.
[Turgeon 2009, p34]
- 216 d** Cytotoxic T cells, which are capable of destroying targets such as tumor cells and virus-infected cells, bear the CD8 surface marker, while the other cell types listed are positive for the CD4 surface marker.
[Stevens 2003, p34]
- 217 a** Contact dermatitis is a delayed type hypersensitivity reaction due to T-cell responses to environmental chemicals or metals. The other conditions are examples of other types of hypersensitivity.
[Mahon 2006, pp.96-98]
- 218 b** Anaphylactic, or type I hypersensitivity, occurs very rapidly, usually within 30 minutes after antigen exposure. While transfusion reactions and serum sickness are also examples of immediate hypersensitivity, they generally do not occur as rapidly. Contact dermatitis is a delayed hypersensitivity reaction, manifesting between 24 and 72 hours after antigen exposure.
[Mahon 2006, pp89-91]
- 219 a** MLS ONLY Normal peripheral blood should contain approximately 80% T lymphocytes and 20% B lymphocytes.
[Turgeon 2009, p52]
- 220 a** CD3 is a marker used to identify T lymphocytes. It is present on the surface of all mature T-cells, regardless of T-cell subset.
[Mahon 2006, p26]

221 d About 70%-85% of peripheral blood lymphocytes should be T cells. The value for the normal control is therefore too low, and the test should be repeated with a fresh control sample before patient results can be interpreted.

[Turgeon 2009, p55]

222 a The absolute number of B lymphocytes would be calculated by multiplying the absolute white blood cell count by the percentage of total lymphocytes to get the total leukocyte count; then multiplying the total leukocyte count by the percentage of B lymphocytes. $8,930 \times 0.30 \times 0.40 = 1,072$.

[Turgeon 2009, p65]

223 a Lymphocytes can be obtained by density gradient centrifugation with Ficoll-Hypaque. Following centrifugation, the lymphocytes can be found in the layer of mononuclear cells that overlays the layer of Ficoll-Hypaque.

[Stevens 2003, p37]

224 c In flow cytometry, a laser beam hits cells as they pass through the instrument in single file. The amount of light scatter is measured from each cell at 2 different angles, and is used to identify the cell type on the basis of size and granularity. Cells are also identified on their ability to emit fluorescence after they have been incubated with fluorescent-labeled monoclonal antibodies that bind to specific surface markers.

[Stevens 2003, p38]

225 c A decrease in the number of T helper (CD4+) cells and a decrease in the ratio of CD4+:CD8+ cells is a characteristic finding of HIV infection and AIDS.

[Stevens 2003, p354]

226 b The total number of T cells is calculated by multiplying the total WBC ($10 \times 10^3/\mu\text{L}$) by the percent of lymphocytes (25%, or 0.25) and the percent of T cells (40%, or 0.40). The answer for this calculation is 1×10^3 or 1,000.

[Turgeon 2009, p65]

227 b A normal individual would have approximately 63%-84% T cells. With the values given in this example, the absolute T cell number would range from 2.52×10^3 (2,520; calculated by multiplying the total leukocyte count (10×10^3) by the % of lymphocytes (40% or 0.40), and by the lower limit of the % of T cells (63%) to 3.36×10^3 (3,360; calculated by multiplying the total leukocyte count (10×10^3) by the % of lymphocytes (40% or 0.40), and by the upper limit of the % of T cells (84%). With a % recovery of 85%-95%, values would range between 2,142 ($2,520 \times 0.85$) and 3,192 ($3,360 \times 0.95$).

[Turgeon 2009, p61, 65]

228 d Laser flow cytometry is the underlying principle of cell sorting into subpopulations.

[Turgeon 2009, p174]

229 c Flow cytometry uses fluorescent-labeled monoclonal antibodies to identify cells of interest by binding to specific components within or on the surface of the cells.

[Turgeon 2009, p173]

230 b The total number of lymphocytes can be calculated by multiplying the WBC (5×10^3 , or 5,000) by the % of lymphocytes (15% or 0.15) to get 750. This number is then multiplied by the % of CD4+ cells (8% or 0.08) to get an absolute CD4 cell count of 60.

[Stevens 2003, pp354-355]

231 c The patient's percent of CD4+ cells (8%) is well below the normal range of 50%-60%, and the patient's absolute number of CD4+ cells ($5,000 \times 0.15 \times 0.08 = 60$) is also far below the normal range of 500-1,300 cells/ μL peripheral blood. These findings are consistent with AIDS, which is caused by HIV.

[Stevens 2003, pp354-355]

232 b Mis-matches in HLA antigens between a donor and recipient of a bone marrow transplant can lead to graft-vs-host disease, in which T lymphocytes in the bone marrow graft mount an immune response against the foreign histocompatibility antigens of the immunocompromised recipient.

[Stevens 2003, pp266, 270]

233 c More than 95% of patients with ankylosing spondylitis are positive for the HLA-B27 antigen; therefore, a positive result for this test would support the diagnosis.

[Mahon 2006, p181]

- 234 d** Hairy cell leukemia cells have surface markers such as CD19 and CD20, which are characteristic of B cells, and other markers, such as CD11c, which are found on monocytes. They also stain positive for tartrate resistant acid phosphatase, which is found in osteoclasts and macrophages.
[McKenzie 2004, p591]
- 235 c** Sézary cells are cells that have the helper T cell phenotype (CD3+, CD4+).
[McKenzie 2004, p592]
- 236 a** CD2 and CD3 are T-cell markers, while surface immunoglobulin is a B-cell marker.
[Stevens 2003, pp29, 30]
- 237 b** HLA-B27 is associated with ankylosing spondylitis. There is a 50% chance that the mother will transmit her B27 allele to her children.
[Mahon 2006, pp172, 181]
- 238 c** Individuals who are HLA-B8+ have a 5× greater risk than HLA B8- persons of developing myasthenia gravis, and a 9× greater risk of developing celiac disease over a lifetime.
[Turgeon 2009, p429]
- 239 a** TdT is an enzyme that adds nucleotides onto the 3' end of a DNA molecule. It is present in immature T cells and B cells, and is used to differentiate ALL from mature B-cell malignancies.
[McKenzie 2004, p491]